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What They See: Noticings of secondary science cooperating teachers as they observe pre-service teachers

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What They See: Noticings of secondary science cooperating teachers as they observe pre-service teachers

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Dissertation

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Doctor of Philosophy

The University of Texas at Austin

May, 2013

Dedication

This work is dedicated to all of my family. In particular, I want to honor the memory of my mother Ruth and my grandmother Victoria. These two women were the trailblazers of a line of curiosity, inquiry, and a passion for knowledge that lives in me still. This work, and all that follow, stem from the seeds that they sowed. Mom and Nana, I love you.

Acknowledgements

There are many people to thank for their support and patience over the past few years. First and foremost, I have to thank my husband, Steve. You gave me advice, inspiration, and, most of all, love when I hit the rough spots. I could not have done this without you.

I would also like to thank my committee chair, Dr. Barufaldi for his unwavering confidence in my work. Your faith in me has made all the difference. To the rest of my committee, Dr. Marshall, Dr. Salinas, Dr. Stroup, and Dr. Gess-Newsome, thank you for your wonderful feedback and direction during this process. You each made a unique and important contribution to this work.

Additionally, I want to thank my fellow graduate students, including the members of my writing group and all my friends from the Sandra K. Abell Institute, whose thoughtful critiques helped me to refine my ideas and whose morale building kept me going. Abell Institute buddies, it meant so much to go through this process with you.

Furthermore, I would like to thank some external mentors. Julie Luft, Heidi Carlone, and Melissa Braaten. You have been beacons as I have tried to navigate these murky waters. I appreciate you as mentors, role models, and friends.

Finally, I would like to thank my family. Being part of a wonderful lineage has made me who I am. The strong, brilliant, and inspiring women in the Rodriguez and Gutierrez families have been kept deep in my heart throughout this process. I hope to have made you proud. And to my Dad – your love is at the foundation of all that I am and all I will become.

What They See: Noticings of secondary science cooperating teachers as they observe pre-service teachers

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The University of Texas at Austin, 2013

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This dissertation explores what cooperating secondary science teachers attend to during observations of pre-service teachers as they enact lessons in their classrooms and how they make sense of what they see. This study applies the teacher noticing framework, recently used in research with mathematics, to the secondary science context and uses it to describe teacher attention. The study also aims to determine if cooperating teachers use the act of noticing to engage in pedagogical reasoning and draw connections to their own teaching practice. As an interpretive qualitative study, the format for data collection and analysis utilized a case-study methodology with cross-case analysis, and used semi-structured interviews, lesson debriefs, collected artifacts, and classroom observations. Data on the four study participants was collected over the 2011-2012 school year. Findings support several conclusions. First, the cooperating science teachers in this study regularly engaged in reflection and pedagogical reasoning through the act of noticing. Second, the cooperating teachers made regular connections to their own practice in the form of vicarious suggestions, reflective questions, comparisons of practice, and

perspective shifts. These connections fostered the emergence of "pivotal moments" or times when the cooperating science teacher self-identified a desire to change their current practice. Third, cooperating teachers used observations of pre-service teachers in their classrooms as a form of professional experimentation and built knowledge in practice through the experience. Lastly, the findings suggest that observations of pre-service teachers be added to the list of professional development activities, like video analysis and lesson study, that help teachers reflect on their own practice. For science teacher educators, this study demonstrates the importance of attending to field experiences as a learning opportunity for the science cooperating teacher. It provides a new way of looking at classroom observations as professional development opportunities and it recommends that teacher preparation programs reconceptualize the tasks they ask cooperating teachers to engage in. Suggestions include designing observation tools that direct teacher noticing toward student learning in science, viewing cooperating science teachers as learners, including metacognitive activities for cooperating science teachers, and reorienting lesson debriefs toward a notion of classroom inquiry.

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Chapter One: Introduction

Yvette watches the pre-service teachers she is mentoring lead her students through a photosynthesis lab during the first period of the day. During her lunch period she takes time to talk with Sarah and Miriam about their lesson. She listens to them share their concerns about pacing the lab and tells them how much she liked how they introduced the lesson. In reference to the fact that they had students draw the experimental set up, she says, "We don't do that, but I think it really helps." As she talks, she walks over to a lab table spread with papers and takes their handouts for her files. She tells the pre-service teachers that she is planning to "steal" parts of their lesson and use it with her other classes. She says, "We usually set up the test tubes for them but they were more engaged setting them up themselves"(Field note summary (pilot study), November 16, 2010).

Yvette is a high school biology teacher working with pre-service teachers as part of their early field experiences in the public schools. Science teachers like Yvette, often called cooperating teachers, work with pre-service teachers as mentors by allowing them into their classrooms to offer authentic teaching experiences that promote reflection and quality teaching practices for the newest members of the profession. While research has shown that cooperating teachers are highly influential in determining the kinds of practices that pre-service teachers will ultimately adopt (Rodriguez, 1998), little attention has been paid to the impact of the mentoring process on the cooperating teacher. This exploratory study investigates the experience of the cooperating science teacher during a particular aspect of the mentoring process, observations of teaching in the cooperating teacher's classroom.

SCIENCE TEACHING AS A COMPLEX ENDEAVOR

Secondary science teachers today face many challenges. Teachers are under pressure to produce students that not only have the knowledge and skills required for post secondary education but also are interested in pursuing careers in a science related field. A report by the National Academies (Augustine, 2005), *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future,* details the importance of increasing the workforce in Science, Technology, Engineering, and Mathematics (STEM) for our nation's economic success. To fulfill this mandate, science teachers must learn to engage an increasingly diverse student population and keep up with the ever-changing dynamics of the twenty first century classroom.

Science teachers must be trained to use appropriate strategies for teaching science while also attending to the specific social, cultural, and developmental needs of the students in their classrooms. They must be prepared to foster high learning outcomes for all of their students while insuring that their students have the problem solving skills to thrive in a world of ever advancing technologies.

In response to this charge, the National Academy of Science (2012) has developed a new framework for developing science standards that characterize and guide high quality science teaching. Recent recommendations suggest that all science teachers need skills in "investigating students' ideas, selecting effective teaching practices, assessing students' progress, and developing classroom communities and discourses in which all students and their ways of knowing are valued and respected" (p. 264). For this

vision to be realized, the science education community will need to pay deep attention to the development of the science teachers who are expected to execute these complex practices.

A Call for Cooperating Science Teachers

Clinical field experiences are one way that teacher preparation programs help pre-service teachers gain the knowledge and skills required to meet the challenges of teaching secondary science. A recent report by The National Council for Accreditation of Teacher Education (NCATE, 2010) calls for teacher education programs to incorporate clinical field experiences into every aspect of their teacher training. Teacher preparation programs are being asked to work together with P-12 schools to provide field experiences that intertwine academic preparation with time spent in school classrooms. This charge calls for new staffing models where experienced teachers, pre-service teachers, and university personnel work together as part of a clinical practice team to integrate academic knowledge with the practical knowledge contributed by practicing teachers and other stake holders (Zeichner, 2010).

As field experiences become more common in teacher preparation, so too will the act of mentoring. Clinical field experiences provide pre-service teachers with an opportunity to apply knowledge and skills in a real world classroom setting as a way to help them develop teacher professional knowledge. Most teacher preparation programs include guidance from a more experienced professional as a standard component of the clinical field experience of pre-service teachers. In a U.S. Department of Education

research report on teacher preparation programs, the clinical preparation of new teachers though field experiences in classrooms (early field experiences and student teaching) was reviewed. In each instance, the teacher preparation program enlisted the services of an experienced cooperating teacher to oversee the classroom performance of the pre-service teacher and provide feedback (Wilson, Floden, & Ferrini-Mundy, 2001).

Given the subject specific challenges that beginning science teachers face (Fletcher & Luft, 2012), the mentoring of pre-service science teachers during the clinical field experience is critical in helping them prepare for the road ahead. In most secondary field experiences the cooperating teacher serving as a mentor is an experienced teacher in the same subject area as the pre-service teacher. This alignment exists because there are subject specific elements of classroom practice for which a teacher in the same field can provide strong guidance. Mentors provide pre-service teachers with support as they learn skills needed for domain specific teaching. It has been shown that mentoring is the most effective when it occurs in the same content teaching domain as the pre-service teacher (Luft, Fletcher, & Fortney, 2005, Smith & Ingersoll, 2004). For example, experienced science teachers are more accurate in explanations of the subject matter, selection of demonstration materials, and representations of science concepts than novices (Clermont, Borko and Krajcik, 1994) and this expertise is a valued resource for new teachers.

Field placements are often offered to teacher preparation programs as a courtesy from partnering schools. Because of the challenges of teaching, secondary science teachers and school administrations are sometimes reluctant to take on the responsibility of working with a novice. Cooperating teachers, whether involved in early field

experiences or student teaching, rarely receive much credit for their participation. However, with NCATE's call for clinically-based teacher education this mindset will need to change. School district personnel and university preparation programs will share accountability for teacher preparation, but why would schools want to take on this additional burden of teacher preparation? According to James Cibulka, President of NCATE,

> New ways of preparing candidates could add value for the school that is often absent in the current student teaching placement. Placing cohorts of candidates in a school for an extended period and using a team approach to working with mentor teachers could benefit the school as well as providing richer learning opportunities for candidates (Cibulka, 2011, p. 4).

Inherent in this statement is the assumption that both cooperating teachers and the pre-service teachers in their classroom will learn as a result of this partnership. There is certainly a rich research base to support one part of this assumption. Research on positive outcomes for mentees includes interpersonal support, assistance with the practices of teaching such as classroom management, instructional routines, and student engagement, opportunities to discuss teaching, and feedback (Ehrich, Hansford, & Tennent, 2004; Evertston & Smithey, 2000).

Fewer studies have examined the impacts of the experience on the cooperating teachers. Though cooperating science teachers have a major role in mentoring new science teachers and helping them develop into experienced educators, we know little

about how the act of mentoring impacts these educators. Meta-analyses have provided snapshots of general benefits of the mentoring experience including collegiality and networking, reflection, personal satisfaction and growth, support, and classroom assistance (Ehrich et al., 2004). These benefits were derived primarily from surveys of cooperating teachers structured around gains hypothesized by advocates. Such data collection strategies may create response bias. In addition, these studies fall outside of the context of the secondary science classroom.

A UNIQUE OPPORTUNITY

Though there has been little research in the area, the experience of the secondary science cooperating teacher provides unique opportunities for study. While pre-service teachers teach sample lessons, the science cooperating teachers observe their work. After the lesson they typically reflect on and discuss lesson outcomes with the pre-service teachers. The work that cooperating science teachers do shares the essential features of observation, reflection, and discussion shown to support teacher learning (Bass, Usiskin, & Burrill, 2002).

Science cooperating teachers also observe pre-service teachers in the *context of their own classroom*. The pre-service teachers and students interact in the classroom space often using the cooperating teachers own materials and resources. This provides an opportunity for the cooperating teacher to attend to the appropriateness of the resources as well as the way the students interact in the physical environment. Attention to elements of classroom context can support teachers as they plan future learning activities.

Additionally, the secondary science cooperating teacher observes the lesson as it is enacted with *his or her own students*. Since the cooperating teacher will be teaching these students in the immediate future it is likely that they are highly motivated to attend to these students' ideas and interactions. In addition, observing a lesson with one's own students allows the cooperating teacher the chance to attend to their socioeconomic, linguistic, and cultural backgrounds. It provides an opportunity to observe the ways in which differences in prior knowledge and academic preparation of their students plays out during the lesson. Observations of this type are not available to mentors engaging in observations of other groups of students.

Finally, the science content of the lesson being observed is often *directly applicable to the cooperating teacher's current topic of instruction*. Unlike elementary teachers, the cooperating teacher in a secondary science setting typically teaches multiple periods of the same content area like Biology, Chemistry, or Physics. Therefore elements of a science lesson observed during a 3rd period class can be of immediate use during a 7th period class. The timeliness of these observations allows for teachers to make immediate use of any insights gained during the mentoring process.

The tasks of observation, reflection, and discussion associated with serving as a cooperating teacher as well as the act of mentoring in the classroom context provides a unique opportunity for learning for secondary science cooperating teachers. The richness of the learning opportunity suggests that investigation of the development of secondary science cooperating teachers is an under explored area.

RATIONALE

The framework for K-12 science education recently published by the National Academies of Science (2012) suggests that, "Teachers are the linchpin to any effort to change K-12 science education" (p.255). Given this statement, attention to the development of not only pre-service teachers but also cooperating science teachers should be an important focus for stakeholders in educational community. Cooperating teachers are part of many school communities yet few studies examine how the work of mentoring may influence their professional growth.

PURPOSE

The purpose of this dissertation is to explore what cooperating science teachers attend to during observations of pre-service teachers teaching in their classrooms, and how they make sense of what they see. Teacher noticing is a framework that has been recently used in research with mathematics teachers to capture and analyze teacher attention. This dissertation study applies this framework to the secondary science context and uses it to describe what science cooperating teachers focus on during observations of teaching in their own classrooms. The study also aims to determine if cooperating teachers use the act of noticing to engage in pedagogical reasoning and draw connections to their own teaching practice. Specifically, the study is guided by the following research questions:

1. What do secondary science cooperating teachers notice as they observe pre-service teachers enact lessons during an early field experience?

2. Does the act of noticing stimulate pedagogical reasoning of the cooperating teacher?

3. What, if any, connections do secondary science cooperating teachers draw between what they notice and their own teaching practices?

LIMITATIONS

The study contains limitations that should be recognized. First, this study included only four teachers, though this represented the majority of the science cooperating teachers on the campus. Second, the findings of this study are limited by context. The results should not be generalized to other populations of cooperating teachers without careful consideration of the subject area, particular aspects of the school culture, the type of teacher preparation program being implemented, and the relationship between these entities.

Additionally, the study included both an open ended noticing form as well as the required structured feedback form provided by the teacher preparation program. It is possible that the predetermined categories present on the feedback form in some way influenced the noticing of the cooperating teachers. Though this is a consideration, using a structured feedback form is common practice for most cooperating teachers. To remove the feedback form would be to alter the nature of the cooperating teacher experience in a

fundamental way. The collection of both the noticing form and the feedback form provides an opportunity to look for alignment or discord between the two instruments. Furthermore, it is possible that the interview process itself had a role in facilitating the construction of connections and insights that were not fully realized by the participants prior to the interview process. Beyond being a limitation, interviewing cooperating science teachers may serve as a valuable data source while concurrently acting as a time for reflection and knowledge construction for interviewees. It should be noted that there was strong alignment between what was written on the noticing form, and comments communicated during the lesson debrief and the interview. This suggests that communicating their ideas may have enriched teacher explanations of their noticing but did not fundamentally change the nature of their attention.

SUMMARY

This dissertation is concerned with exploring the attention of cooperating science teachers, their pedagogical reasoning, and the ways in which they consider their own practice during the work of observation and feedback giving. Findings from this study add to research on cooperating teachers and specifically contribute to research on mentors in the secondary science classroom. Purposeful attention and cultivation of secondary science cooperating teacher practice is of particular importance. These teachers stand at the crossroads of several educational communities. They work as classroom science teachers, serve as teacher educators, and often serve on campus and district science teams. Each of these communities comes into contact with their instructional practices.

Additionally, this research has the potential to redefine school/university partnerships into robust and cooperative teams in which the pre-service teachers and mentor teachers both benefit. Finally, this work has the potential to directly impact future STEM workforce efforts by helping all science pupils learn through improved science instruction. In these ways, attention to the development of cooperating science teachers should be an area of particular interest for those working to improve science education.

OVERVIEW OF CHAPTERS

The second chapter of this dissertation includes a discussion of the literature relevant to this study. These areas include literature on teacher knowledge, teacher learning, teacher observation, and teacher noticing. The chapter also describes the noticing framework, which will be used to explore the experiences of the cooperating science teachers in this study. Chapter three characterizes the research design, the methodology, and the data collection and analysis methods for the study. Chapter four will present the cases of the four cooperating secondary science teachers included in the study. The chapter starts by describing each case in detail and then provides a cross case analysis which describes trends in the data. Chapter five will interpret the study data, draw connections between the findings and the relevant literature, and discuss the implications of these findings for the science education community.

Chapter Two: Literature review

The following chapter will discuss literature relevant to this dissertation. This chapter presents literature in four main areas: teacher knowledge, teacher learning, teacher observation, and teacher noticing. These four areas have been synthesized to establish a framework for this study. Figure 2.1 provides a visual representation of the framework described in this chapter.

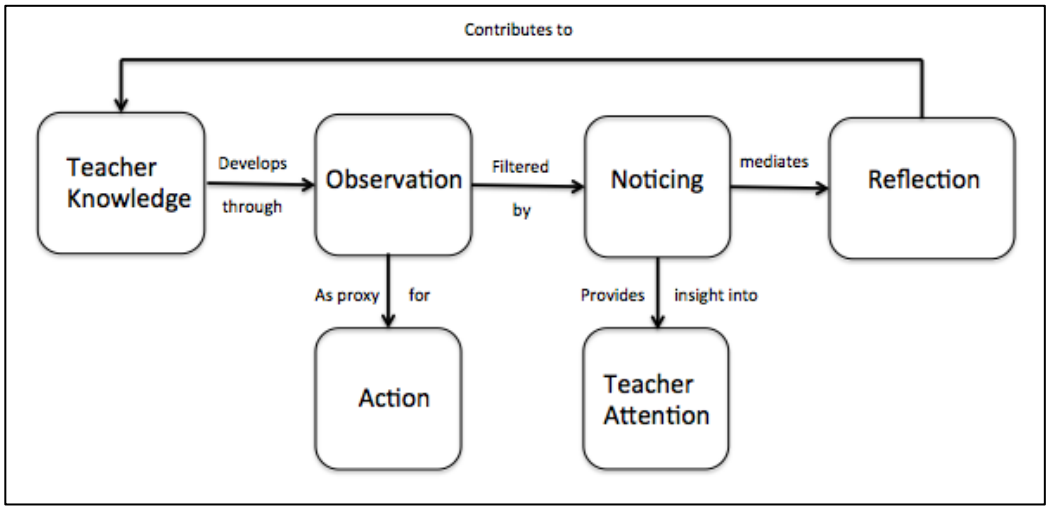


Figure 2.1. Chapter two framework.

Many learning cycles describe teacher knowledge as developing through action and reflection. However, this figure shows the way in which knowledge can also develop from observation and analysis of classroom practice. Central to this figure is the notion of teacher attention and it's role in mediating professional growth. In this figure teacher noticing is depicted as a mechanism for gaining insight into teacher attention during observation and reflection.

TEACHER KNOWLEDGE: PERSPECTIVES AND VIEWS

The purpose of this dissertation is to explore what cooperating science teachers attend to during observations of pre-service teachers teaching in their classrooms and how they make sense of what they see. Much of what we know about cognition in practicing teachers comes from the professional development literature. In an examination of the research on teacher learning, Wilson and Berne (1999) highlight several principles that crosscut the professional development of practicing teachers. One theme to emerge from the literature is the need for teacher learning activities that involve a community of learners. They found that most effective activities allowed teachers to meet together, form networks, and support one another. Another theme found in effective professional learning experiences was a focus on knowledge construction and activation rather than on knowledge dissemination. The authors argue that activities that help teachers understand their own knowledge are more likely to instigate change than activities where teachers are provided with strategies or curriculum. The authors also suggest that learning activities that are the most successful for practicing teachers are those that are matched in the content area and context in which they teach.

In another review of the professional development literature, Cochran-Smith and Lytle (1992) identify various conceptions of teacher knowledge that exist. They provide a framework to describe the notions of teacher knowledge that underlie the types of learning activities provided by various professional development programs. In their work, the authors identify three different conceptions of teacher knowledge.

The first notion is the concept of *knowledge for practice*. This is described as a formal body of knowledge that is determined by and codified by researchers or external experts. Knowledge for practice is a body of knowledge that has been developed about what teachers should know and be able to do. An example of this comes from the work of Lee Shulman (1987) and his framework of a knowledge base for teaching. The assumption underlying this view of teacher knowledge is that it is generated and categorized outside of the classroom and is disseminated to teachers by experts. In this view, teachers are seen as the consumers of knowledge, something to be acted upon through professional development activities or trainings. Teacher effectiveness is then measured by how well teachers enact this predetermined set of identified practices. Many trainer of trainer professional development models operate under the conception of knowledge for practice.

Another conception of teacher knowledge is *knowledge in practice*. According to this view teachers develop knowledge as they experience, interpret, and reflect on their teaching practice. This perspective on teacher knowledge is sometimes referred to as practical knowledge (Duffee & Aikenhead, 1992) or craft knowledge (Grimmett & McKinnon, 1992) and defined as integrated knowledge that is an amalgam of teacher experience, both formal and informal. Those operating within this notion of teacher knowledge see teachers as generators of knowledge. Teachers are seen as designers and decision makers that create knowledge through the act of teaching. According to this view,

"Teaching is understood primarily as the process of acting and thinking wisely in

> the immediacy of classroom life, making split second decisions, choosing among alternative ways to convey subject matter, interacting appropriately with an array of students, selecting and focusing on particular dimensions of classroom problems. To do this outstanding teachers draw on the expertise of practice or more precisely on their previous experiences or actions as well as their reflections on those experiences." (Cochran-Smith & Lytle, 1999, p. 266)

Cochran- Smith and Lytle suggest that new knowledge is created as teachers are confronted with new or surprising situations. In this view, it is through instructional decision-making and reflection that teachers develop the informed practices that help them to become more effective. From this perspective, teacher knowledge is made evident in the best practices seen in observations of expert teachers in the domain.

A final conception identified by Cochran-Smith and Lytle is that of *knowledge of practice*, or praxis. This view rejects the distinction between formal knowledge and practical knowledge. In contrast, this view suggests that teachers and external experts across the span of experience problematize the classroom in different ways and therefore each bring a useful perspective to the conversation. Teachers are seen as generators of knowledge in a collaborative context. And, knowledge is seen as being constructed within the broad communities that form when teachers come together to talk about their own classrooms, larger school context, and overarching questions about education. In this way, knowledge of practice can be seen as a shift from a personal perspective to a broader more collaborative perspective on teacher knowledge.

TEACHER LEARNING: ACTION AND REFLECTION

From the perspective of knowledge in practice, knowledge for teaching is generated through the experience of teaching itself. Teachers learn about and refine their practice throughout their careers. They build knowledge from a variety of sources and experiences. During a 2002 professional development workshop sponsored by the National Research Council, Deborah Ball asserted that one learns about teaching from doing it, reading about it, and watching it. She characterized learning the practices of teaching as a design cycle where teachers are involved in generating designs, using the design with their students, analyzing the effectiveness of the design, and then revising the design for the next step (Bass, Usiskin, & Burrill, 2002). In this view, the action of teaching is a necessary part of the learning process and the act of reflection and analysis are mechanisms for the development of new knowledge.

Perspectives on action and reflection.

The idea of reflecting on practice is not a new one and has been applied to many professional fields. In his work, Schon (1983) focused on reflection as used by professionals including teachers. He called this type of reflection reflective practice and he described it as a time when "the practitioner allows himself to experience surprise, puzzlement, or confusion in a situation which he finds uncertain or unique. He reflects on the phenomena before him, and on the prior understandings which have been implicit in his behavior" (Schon, 1983, p. 68). Schon describes observation and reflection as an

"experiment" that supports teachers in developing new ways of understanding their classroom practice.

Like Schon, Kolb (1984) suggests that experience is required for learning and that it is through reflection in and on action that we come to develop new knowledge. Kolb suggested a theory of experiential learning that has its ideas rooted in experience and reflection as outlined in the work of Piaget, Dewey, and Lewin. Kolb described experiential learning as a holistic theory of learning that emerges from integrated experience of thinking, feeling, perceiving, and behaving as one interacts with the environment. He describes learning as, "the process whereby knowledge is created through the transformation of experience" (p. 38). Kolb's experiential learning cycle (Figure 2.2) includes four elements: concrete experience, reflective observation, abstract conceptualization, and active experimentation.

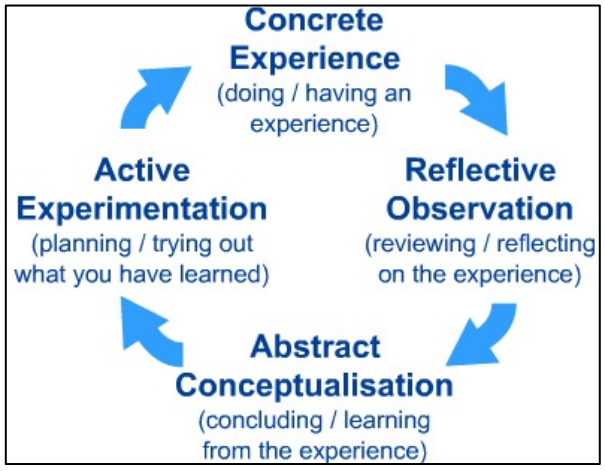


Figure 2.2. Kolb's experiential learning cycle

In his work, Kolb describes several tenets of experiential learning. First, he

asserts that learning should be viewed as a process rather than an outcome. He implies that "ideas are not fixed but are formed and reformed through experience" (p. 26). In this way Kolb considers ideas to be on a continuum of development and refinement and, he suggests all learning as relearning. Secondly, Kolb argues that learning is a continuous process of transformation grounded in experience. He suggests that, as humans, we are continually testing out thoughts and ideas. This process of experimentation occurs naturally and serves to generate new knowledge. Thirdly, learning involves a transaction between the learner and the environment. Thus, the term experience takes on both objective and subjective meaning. In Kolb's view the objective experience is influenced by the what and the where of the experience. For example, the experience could be defined by what is being done or where the activity is taking place. In contrast, the subjective side of experience includes the who and the why. What are the past personal experiences of the learner and what is their motivation for engaging in the activity? Lastly, Kolb suggests that to understand learning, one must understand knowledge. For him, these two concepts are intertwined.

The relationship between learning and knowledge, suggested by Kolb, was further explored by Lee Shulman (1987). Shulman applied the notions of experiential learning and reflective practice to the area of education. Shulman argues that the value of teacher knowledge is in its use in the everyday decision making of teaching. In his work, Shulman articulates the concept of pedagogical reasoning and action (Figure 2.3). This notion of teaching is grounded in a view of teaching as an active cyclical process that generates new teacher knowledge.

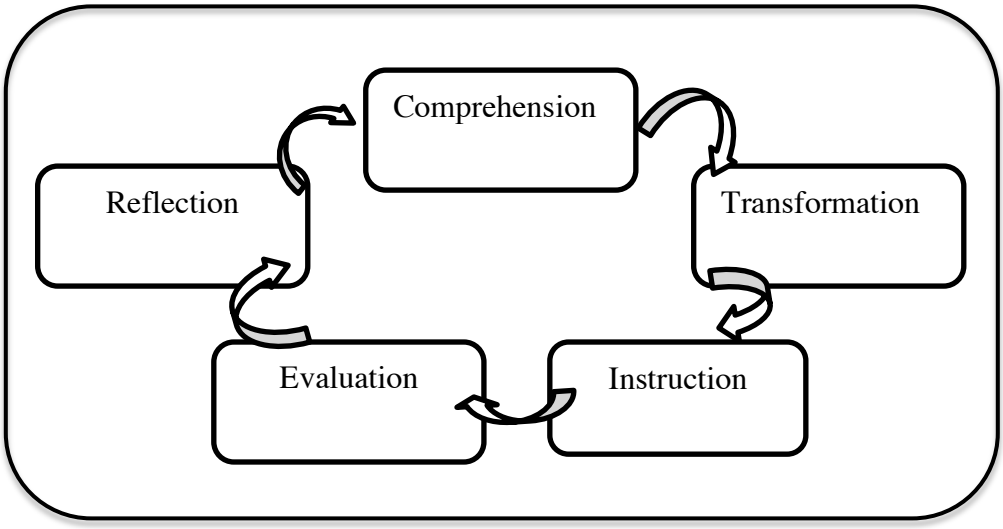


Figure 2.3. A depiction of Shulman's notion of pedagogical reasoning

Shulman argues that teaching "begins with an act of reason and continues as a process of reasoning" (1987, p. 13). He describes the act of pedagogical reasoning as a transformative inquiry process that includes evaluation of instruction, reflection, and coming to a new comprehension of one's teaching practice. Like Schon and Kolb, Shulman asserts that teachers engage in this process as they go about the experience of teaching. He suggests that this reflective learning cycle is informed by and serves to inform various aspects of teacher knowledge.

The interconnected model of professional growth.

The interconnected model of professional growth (Clarke & Hollingsworth, 2002)

is a learning model that ascribes the construction of teacher knowledge to action, attention, and reflection (see figure 2.4). At the core of this model is the conception of experiential learning as put forth by Kolb (1984). This model contains the essential features of experiential learning including experience, reflection, abstraction, and experimentation. It also highlights the role of one's attention during an experience in directing reflection and the construction of new ideas and orientations.

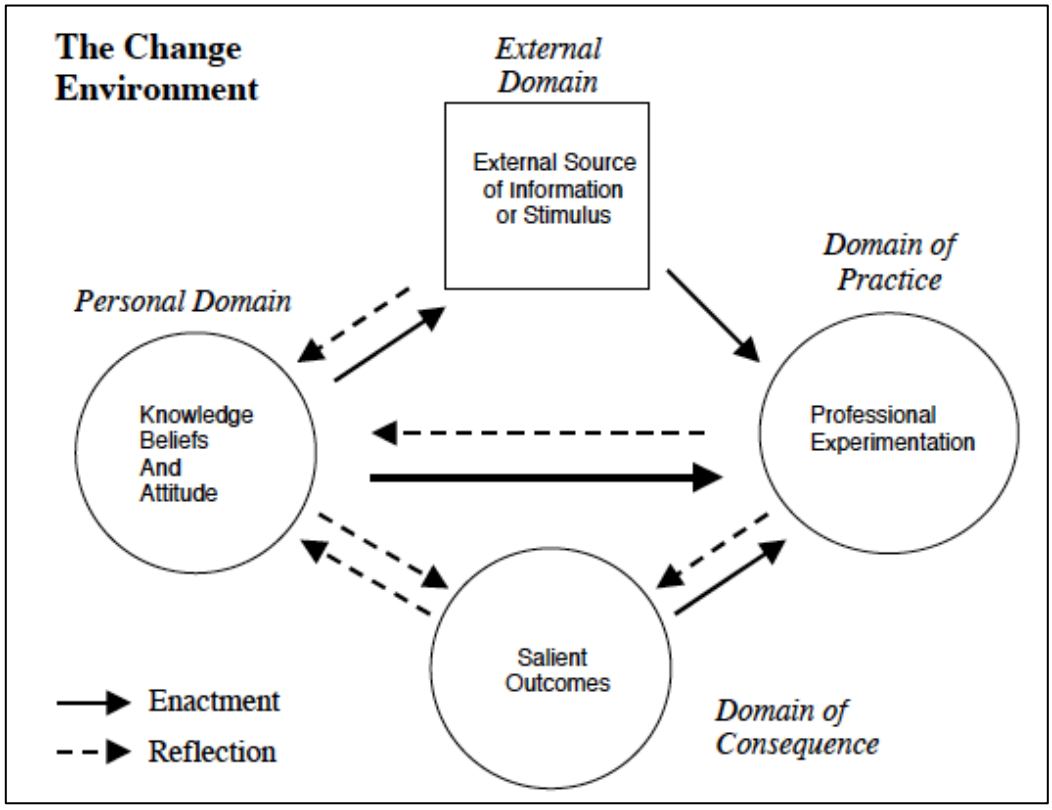


Figure 2.4. The interconnected model of professional growth (Clarke and Hollingsworth, 2002).

This model suggests that attention is integral in shaping the way that teachers make sense of and come to adopt new classroom practices. In this model, teachers try out

new practices and then pay attention to salient outcomes like student understanding or student behavior. Teachers then reflect on these outcomes and make decisions about the practices or attitudes they will adopt or reject.

This non-linear model recognizes that teacher learning is an ongoing process that is continually occurring through the professional activities of teachers as well as through designed professional development. As in the work of Schon (1983) and Shulman (1987), this model suggests that change occurs via the processes of enactment and reflection on the part of the teacher. As designers of their own learning experience, teachers engage in professional experimentation during the act of teaching.

Finally, this model allows for interaction between elements that may influence teacher learning. In line with Kolb, this model acknowledges both the objective and subjective factors of the learning experience. The model illustrates the interplay between teacher action, interpretation, beliefs, the source of new ideas and so on. It is through this interplay that teachers develop their knowledge of practice or craft knowledge. This model recognizes the multiple pathways of knowledge acquisition that exist for different individuals, circumstances, and contexts. And, it depicts teacher attention as tied to their attitudes and beliefs. For example, some teachers may consider depth of student understanding an important outcome to attend to while others may be more concerned with the effective use of time.

TEACHER OBSERVATION: A PROXY FOR ACTION

Central to the development of *knowledge in practice* are the notions of action,

evaluation, and reflection. Under this concept, learning takes place as the result of teacher instruction and reflection on instruction. While teachers certainly learn in this way, this section will provide several examples of professional development activities in which the observation of others is substituted for the act of instruction.

In 2002, the National Research Council hosted a professional development for classroom teachers that focused on studying classroom practice (Bass, Usiskin, & Burrill, 2002). The conference grouped several practices, including Japanese lesson study, analysis of video of classroom teaching, and case studies under the umbrella of learning from classroom teaching. Common to each of these practices are the essential elements of learning from observation, reflection, and discussion. In each of these examples the observation of others serves as a proxy for the act of instruction.

Japanese Lesson Study.

Despite the recognition that reflection on practice is a powerful source of learning, the act of observing and analyzing a colleague's classroom teaching for the purposes of teacher learning is still uncommon in the United States (Darling-Hammond & Ball, 1998). However, literature on Japanese Lesson Study (JLS) demonstrates that other countries make regular use of this practice as a form of professional learning. Figure 2.5 (Lewis, Perry, & Murata, 2006, p. 4) illustrates how the practice of JLS supports teachers using observations of classroom teaching as the basis for teacher development. This model shows that during JLS teachers begin the process by working together to identify and describe learning goals. The teachers then jointly plan a lesson

designed to achieve those goals. In the next stage, the teachers observe the lesson as it is enacted in the classroom. After the observation, the teachers share their impressions and reflect on their observations. This leads to informed refinement of the lesson and the formulation of questions to be explored during the next lesson study cycle.

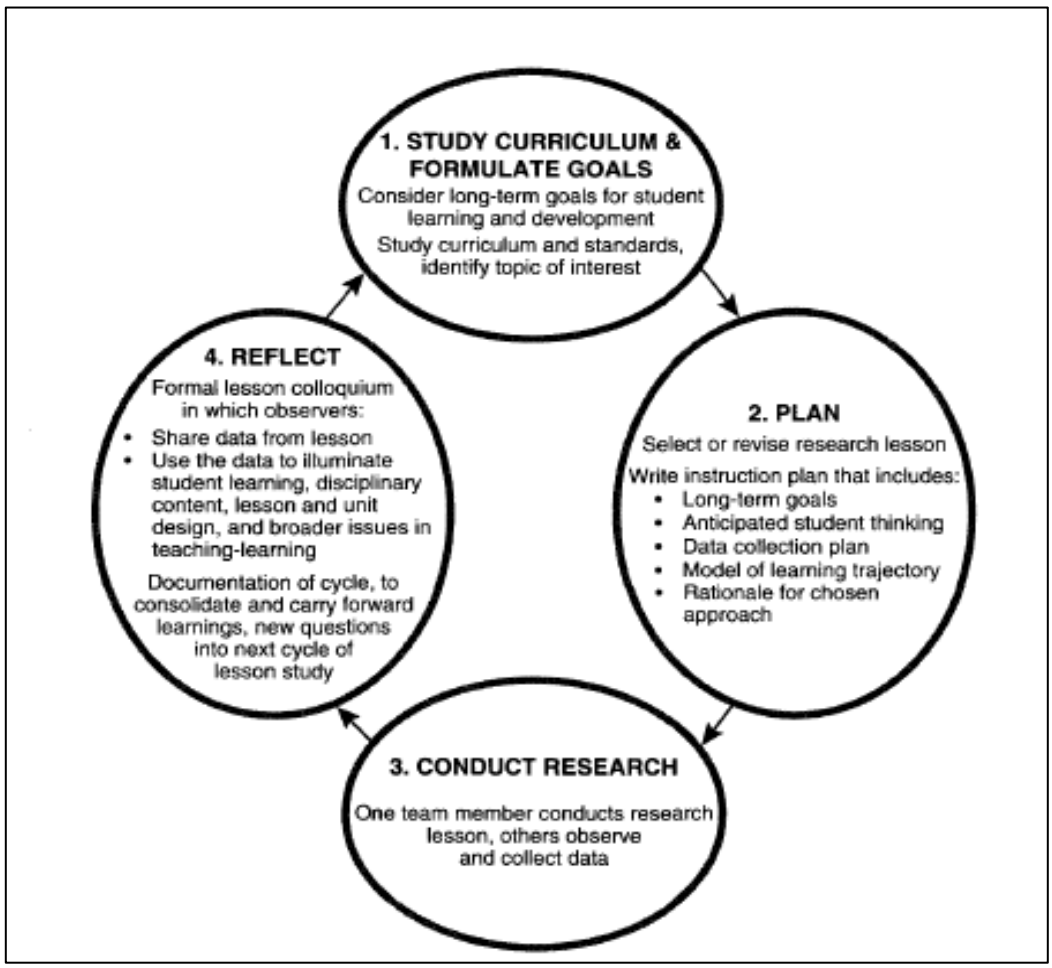


Figure 2.5. Lesson study cycle (Lewis, Perry, & Murata, 2006)

In her work, Lewis (2000) highlights several ways in which the practice of JLS contributed to the improvement of Japanese teachers. In her study, Japanese teachers reported gaining new insight about their teaching from watching the practices of others,

watching the children being taught, being exposed to new content and pedagogical approaches relevant to their subject area, and being provided with an opportunity to get various viewpoints about a common lesson. The teachers in this study also relayed that this type of professional development made them want to improve their classroom practice.

The work on JLS suggests that teachers learn from observations of classroom practice. This assertion is supported by literature on teacher professional development that shows teachers' own classrooms to be productive learning environments (Ball & Cohen, 1999; Putnam & Borko, 2000). In a review of the related research, Gess-Newsome (2003) suggests that "studying and learning from one's classroom experience, in turn, adds to the context-specific professional knowledge valued by teachers and directly improves classroom practice – the ultimate site of reform efforts" (p. 95-96). Her review points out the importance of opportunities for teachers to connect their own learning to their everyday classroom practice.

Video Cases.

Other professional development experiences have attempted to capitalize on practices that engage teachers in observation and reflection on teaching by building learning experiences for teachers around video analysis (Ball & Cohen, 1999; Sherin, 2007; Shulman, 1992). Analysis of teaching video is a standard component of many teacher preparation programs (Barnett, 2006). Analysis of these videos may take the form of watching another inservice teacher, a pre-service teacher, or watching one's own

teaching practice. Rich and Hannafin (2009) described the variety of tools developed to help teachers use video to analyze classroom practice. Websites such as InTime, TeachScape, LessonLab, CaseNext, and TeachFirst are provided as examples of online learning communities that provide video of teacher practice for analysis by pre-service and inservice teachers. In addition to the multiple websites offering video clips, Rich and Hannafin described numerous video annotation tools that have been developed. These tools allow viewers to make written comments on videos as they view them. Some tools have functions that allow for collaboration such as multiple users viewing the same video at one time or tools that allow for participants to share and comment on each other's annotations.

The emergence of video annotation tools like VAST, VITAL, Video traces, and Video paper reflect the continued popularity of video analysis in teacher education. These tools have been used to support the professional growth of inservice teachers as well as pre-service teachers in science and mathematics teacher preparation programs (Sherin & vanEs, 2005).

In 2000, Clarke and Hollingsworth made a case for the use of video cases to support the development of professional knowledge in both pre-service and inservice teachers. The article describes the different ways in which professional development programs have used video as a basis for learning activities. The types and purposes of the cases provided were shown to vary based on the goals of the specific program. The authors discuss four categories of video cases in use. The first category is comprised of video cases that are used to illustrate cross-cultural examples of teaching. Videos of

teaching in two different countries are used as the basis for reflection on and analysis of teaching practice in various contexts. Another use they identified was the use of video cases as examples of classroom practice. In this case the videos are used as a way for observers to pay attention to and reason about the actions of both teachers and students. In another category, structured illustrations, videos are used to illustrate a specific teaching principal or practice. Finally, the authors identify the category of problematic cases. These videos illustrate a problematic situation and stimulate a discussion about the various options available to the teacher.

Common to each of these categories of cases is the act of observation, reflection, and analysis of teaching. The authors suggest that video cases are useful in facilitating teacher reflection, that they allow teachers to attend to aspects of their own practice or that of other teachers that had previously gone unnoticed, and that video cases can support the formation of a community experience by using shared language and a shared activity to discuss relevant aspects of teaching and learning.

Some research on video cases has focused on the impact of observation and analysis of video on the observer. A 1996 study by Copeland and Lynn Decker investigated the effect of video case observation and reflection on pre-service teacher cognition. The investigators studied the way in which the collaborative analysis of video cases served to shape pre-service teachers' ideas about teaching and learning. The participants in this study were 12 pre-service elementary school teachers. The teachers were first asked to individually watch a short video of teaching which represented a variety of issues related to teacher and student dynamics in the elementary setting. The

teachers were allowed the opportunity to review the video in part or in whole until they felt adequately familiarized with the video content. After viewing, the pre-service teachers participated in an interview in which they reported on their initial impressions of the video. Next, the teachers were placed in groups, asked to discuss the video, and to create a summary statement reflecting the group's interpretations of the video with regards to classroom practice. Finally, the pre-service teachers were asked to complete a second individual interview similar to the first.

Findings from the study suggest that over a third of the time, the pre-service teachers changed their interpretation of the video after talking with peers. This finding suggests that the pre-service teachers interpreted their observations in different ways and that discussion of these various interpretations was instrumental in shaping their final impressions of what they saw.

Another study that explored the impact of video analysis on pre-service teachers was a 2004 study conducted by Van Den Berg, Jansen, and Blijleven. The study explored the ways in which watching a video case impacted pre-service teachers' learning and transfer. The study explored the experiences of 46 pre-service elementary teachers as they engaged in learning about designing outdoor science activities from a video case example. These cases included video segments of teaching events, links to lesson plans and curriculum resources, and commentary from various perspectives including a teacher, science teacher educator, and a curriculum specialist. The video case also included information about the context in which the lesson was taking place including detailed information about the school. The study explored whether or not teachers felt that the

video case was a worthwhile learning experience, what information the pre-service teachers were able to extract from the case, and whether or not the pre-service teachers could transfer the information acquired to different contexts.

Findings of the study showed that 87% of the pre-service teachers valued learning from the video case. The study also showed that the pre-service teachers were able to extract procedural and organizational information from the video case such as planning suggestions and the design guidelines for the experience. The pre-service teachers in this study were not asked to report on their acquisition of conceptual knowledge or to report on what they observed about the students in the video. Several of the pre-service teachers in the study went on to construct a similar learning experience for students. For the most part, the pre-service teachers used what was seen in the video as a "script" by mimicking the strategies observed. However, some students were able to design an original learning experience inspired by the video case they had watched.

While the previous two studies focused on pre-service teachers, an example of using video observations to facilitate growth in professional knowledge in practicing science teachers comes from the work of Melissa Braaten. Braaten (2011) followed 16 science teachers as they participated in a year-long video club. Video clubs have been shown to facilitate teacher learning in both the mathematics and science context (Windschitl, Thompson, & Braaten, 2011; Sherin and vanEs, 2009; Borko, Jacobs, Eiteljorg, & Pittman, 2008). The video club in Braaten's study was developed based on the notion that "teacher learning must be situated in the problems, concerns, and challenges of teachers' everyday classroom practice" (2011, p. 15). The teachers in this

study attended a video club one evening a month. At this meeting teachers would bring in videos of their own teaching along with student work to share with the other teachers in the group. These artifacts would then be used as the substance of collaborative discussions of teaching practice, which was facilitated by a conversation protocol. The club sought to help teachers improve their practice in four areas including using exploratory models to reframe science teaching, attending to student ideas, organizing activities to help students form and challenge models, and supporting students in forming evidence based arguments. Findings from the study show that, over time, several teachers changed their participation in the group by coming to question their own assumptions about classroom practice, student learning, and subject matter. This shift in the teachers' approach to video analysis suggests that teachers gained insight about their teaching practice through the act of observation of and reflection on classroom teaching.

Mentoring.

During the work of mentoring, cooperating teachers engage in *observation, reflection, and discussion* of the lessons they see. These essential features have been shown to support teacher learning in studies of JLS and video cases. The nature of this work may promote the development of knowledge for teaching in ways that are not easily accessible for other types of mentors. According to Cochran-Smith & Lytle (1999), teachers generate knowledge in practice as they confront and attempt to make sense of novel situations that develop in the classroom. The cooperating teacher mentor has a unique perspective from which to observe of these types of classroom events and reflect

on them. In addition, the act of providing feedback to the pre-service teachers provides the cooperating teacher with a built-in opportunity to discuss their thinking.

Cooperating teachers mentor pre-service teachers in the context of their own classroom, yet few studies have explored the possible benefits to the mentor. Even fewer have investigated mentoring as a possible educative experience. Ehrich et al. (2004) examined 159 studies of formal mentoring programs. They noted that less than half of the studies they reviewed sought opinions from the participating mentors. The data on mentor teachers that was available came primarily from surveys given to cooperating teachers at the end of the mentoring experience. From this data the authors suggested that, "mentoring yields benefits for mentees and mentors" (p. 520). In their review, the most frequently cited benefit to mentors was collaboration and networking opportunities with other professionals. For example, Downey (1986) described the exchange of ideas that resulted from the mentor-mentee relationship and noted that mentors appreciated the opportunity to share ideas with other teachers through the mentoring process.

Another reported benefit of the reviewed studies was "reflection or reappraisal of beliefs, practices, ideas, and or values" (Ehrich et. al., 2004, p. 523). The review showed that mentoring encouraged teachers to reflect on their own practice, a finding that echoes the results of research on JLS and video cases. Ehrich et al. (2004) also noted that 17% of the studies described the ways that mentoring facilitated the professional development of the mentors. This finding is supported by the work of Murray, Mitchell, and Dobbins (1998) who studied an Australian mentoring program for beginning teachers. Two thirds of the mentors in their study mentioned that "serving as a mentor has caused teachers to

reflect on their own teaching knowledge, beliefs, and practices" (p. 24). The study also reported that mentors broadened their knowledge through participating in the mentorship program. Refinement of specific skills such as time management, written communication, and interpersonal skills were reported as benefits.

Some mentoring studies focus specifically on mentoring in the area of science education (Bradbury & Koballa, 2007; Crawford, 2007; Hudson, 2007; Schneider, 2008; Upson, Koballa, & Gerber, 2002). Bradbury and Koballa (2007) studied the type of feedback given by two secondary science mentors to their pre-service teachers from an alternative certification program. Data was collected through observations, field notes, and interviews. In contrast to their incoming expectations, mentors provided more feedback related to general pedagogy than in the area of science specific content knowledge. Missing were discussions of inquiry, scientific literacy, and the nature of science. In 2010, Koballa, Kittleson, Bradbury, & Dias examined the cultural tools that teachers used to learn about mentoring. As part of a 50-hour mentoring workshop, teachers reported learning about being a mentor from discussion and classroom observation tools. While both of these studies examined the mentoring process, neither examined what the mentors learned that would directly impact their knowledge of teaching or classroom practices.

Nilsson and van Driel (2010) focused on the ways in which pre-service teachers and cooperating teacher mentors learned while working together on science instruction in an elementary context. Data was collected from planning sessions, stimulated recall of the lesson, and written reflections. The study found that mentors "learned much from

working together with the student teachers and from observing both their own and the student teachers' teaching" (p. 1313). Findings from the study suggest that serving as a mentor gave elementary cooperating teachers the opportunity to observe and reflect on both content and student interactions. The cooperating elementary teachers reported learning about instructional strategies, content, and their pupils through their work with pre-service teachers. Both the student teachers and the mentors felt that they grew in their understanding of science, but noted the limitations of low levels of content knowledge. Others have noted such limitations. Appleton (2008) noted that secondary and elementary teachers vary greatly in their content preparation. In contrast to secondary teachers who teach a single subject across multiple periods in a day, elementary teaching is episodic with few opportunities to develop disciplinary knowledge. As a result, mentoring conversations rarely focus on subject matter. This finding is supported both by Wang (2004) and Hudson (2007), noting the absence of discussions of subject matter knowledge in mentoring conversations.

Ehrich's review (2004) provides evidence of professional growth resulting from the act mentoring and suggests the promise of mentoring as a learning activity. The work of Nilsson and van Driel (2010) suggests that cooperating teachers in an elementary science context learn about instruction, science content, and their students. In reviewing these studies, however, it is clear that there are contextual differences between mentoring science teachers in an elementary and secondary context leaving an important gap. There is no current research investigating the experience of cooperating teachers when operating within the secondary science setting.

TEACHER NOTICING: INSIGHT TO TEACHER ATTENTION

Findings from studies of JLS and video cases have shown that teachers can learn from reflection on the actions of others. These findings suggest that classroom observations can serve as a reasonable substitute for teacher action in promoting professional growth. Central to the learning model put forth by Clarke and Hollingsworth (2002) is the notion of attention to specific classroom events. Therefore, investigating teacher attention can provide insight into how attention directs teacher professional growth.

The noticing framework in mathematics education.

The concept of *teacher noticing* is a recent framework found in the literature on mathematics education. It highlights what teachers pay attention to as they observe a specific classroom practice and how they interpret the events that stand out to them. This construct can provide insight into teacher thinking by elucidating what events cooperating teachers attend to as well as what they omit as they watch pre-service teachers enact lessons in their classroom. This framework has been used in several studies that focus on unpacking teachers' observation of classroom practice (Jacobs, Lamb, & Philipp, 2010; Sherin & van Es, 2009; Star & Strickland, 2008).

The noticing construct suggests that teacher noticing is an active process in which teachers direct their attention to specific events of importance (Erickson, 2011). It also suggests that teacher noticing is intentional and what one teacher notices in a scene may

be different from another (Mason, 2011). In their work on teacher noticing, Sherin, Russ, and Colestock (2011) describe the various conceptions of teacher noticing used in the literature. These each include one or more of the following elements: 1) teacher identification about what is important or noteworthy in a classroom situation, 2) teacher interpretations about the activities they identify, and 3) the ways that teachers reason about and plan to respond to what they observe.

In the 1980's Fredrick Erickson conducted some of the earliest studies on teacher noticing. These studies took place in elementary contexts where the students and teachers remained together all day and where the teacher was a content generalist. From this work he proposed that teacher noticing was selective (teachers did not pay attention to everything), instrumental (teachers paid attention to things that required teacher action), and multidimensional (teacher noticing covered a range of topics from content, to knowledge of specific students, to general pedagogy). He also suggested that teacher noticing was highly variable across the teachers he studied and that what the teachers noticed was influenced by their prior experience (Erickson, 2011).

The content and structure of teacher noticing in a group setting has been characterized in the work of van Es (2011). Her study centered on the evolution of collective noticing in seven elementary school teachers participating in a video club. The teachers were asked to bring in video clips of their teaching to share with the other members. Specifically, the teachers were asked to capture video clips that they felt illustrated students' mathematical thinking. van Es studied collective teacher noticing through analysis of the comments they made when discussing the video as a group. In

her analysis, van Es was able to break collective teacher noticing into levels based on what the teachers noticed, how focused their noticing was, and whether their focus was primarily evaluative or interpretive.

van Es (2011) went on to describe four levels of collective teacher noticing: baseline, mixed, focused, and extended. Baseline noticing referred to undirected noticing of teachers at the start of the study. At this level the teachers were taking in the whole classroom without a specific focus. The teachers formed general impressions from their observations and their comments were mostly evaluative with no specific evidence to support their interpretation. As the study progressed, teacher noticing shifted to categories described as mixed and focused. At this level the teacher noticing was described as giving attention to specific students and specific pedagogical moves. The noticing on this level was also characterized as being more interpretive than evaluative. Teacher noticing at the end of the yearlong study was described as extended. By this stage the teachers were able to draw relationships between their focused noticing and a particular classroom outcome. Though the work of van Es provides insight into the content and structure of collective teacher noticing, it does not describe the content and structure of noticing for individual teachers. Nor does it speak to teacher noticing in the context of a teacher's own classroom or when occurring in a secondary science context.

Alan Schoenfeld contributed a closing chapter in a recent publication about mathematics teacher noticing (Sherin, Jacobs, & Phillip, 2011). In this chapter, Schoenfeld makes several assertions about the relevance of the teacher noticing framework. He suggests that what teachers notice shapes what they do and don't do in

their classrooms, that teacher noticing can lead to change in practice, and that noticing is tied to teacher beliefs and orientations. He also includes several important questions in the final chapter of this book. He asks if teacher noticing is trainable, what different pathways or trajectories exist in terms of the noticing of teachers with different levels of experience, if teacher noticing is context specific, and how can teacher noticing be productively studied. Answers to these questions would be useful in more deeply understanding teacher attention and its role in the evolution of teacher practice.

The noticing framework as applied to science education.

Though the teacher noticing framework is particularly prevalent in the literature on mathematics education it is being newly realized in the area of science education. Research focusing on science teacher noticing is currently finding its way into the literature base.

In a 2013 study, the noticing framework was used to explore the attention of 43 pre-service science teachers as they evaluated student understanding of scientific inquiry during a video taped science unit (Talanquer, Tomanek, and Novodvorsky, 2013). During this study, a group of pre-service biology teachers were provided with a video taped lesson as well as artifacts such as teacher lesson plans and student work. From this body of information they were asked to select two pieces of evidence and use them to make claims about the students' understanding of inquiry. The written pre-service teacher responses were analyzed as a way of identifying what the pre-service teachers noticed. The pre-service teacher noticing was found to fall within two broad categories, Task-

General and Task-Specific. Task-General noticing focused on general elements of the lesson such as attention to learning objectives and presentation issues. Task-Specific noticing centered on the student's abilities when performing scientific investigations. Findings from the study suggest that the pre-service teachers noticed more about process skills, such as designing and conducting the experiment, than the analytical skills on display during the investigation.

Another recent article by Russ and Luna (2013) describes the ways in which video technology is used to capture local teacher noticing during the act of secondary science instruction. Local teacher noticing is described as minute by minute noticing that occurs over the course of a single lesson (Rosenberg, Hammer, & Phelan, 2006). In this study, a science teacher wore small video cameras while teaching a lesson. The technology enabled her to click a record button and save 30-second clips of classroom action that she identified as noteworthy. The clips were later used as the basis for stimulated recall interviews in which the teacher described why a particular event was captured as noteworthy.

The study went on to use the concept of framing (Scherr & Hammer, 2009) to make inferences about how the teacher was making sense of what she noticed. To do this, the authors analyzed the language that the science teacher used to describe her noticing during her post interviews. Findings from the study show that the science teacher interpreted her noticing about classroom discussion in terms of the connections her students were able to draw between various biological concepts. In contrast, when describing her students' work during lab activity, the teacher's interpretations focused

primarily on procedural skills.

The noticing framework is a framework from mathematics education that is making inroads into the science education community. This framework provides a way of capturing what secondary science cooperating teachers attend to and how they make sense of the complexity of their own classroom. It provides information about the elements of the classroom the cooperating teachers identify as important when given the opportunity to observe pre-service teachers enacting science lessons. Attending to secondary science cooperating teachers noticing can provide insight into how they are experiencing the act of observation in their own classroom, how they are interpreting what they see, and in what way the observation process may be contributing to their knowledge of teaching science.

SUMMARY

In summary, teachers develop knowledge in practice through action and reflection. This chapter has shown that teachers can also develop this knowledge from observing and analyzing classroom practice. Serving as a cooperating teacher is a classroom practice that shares the features of observation, reflection, and discussion shown to facilitate teacher learning. The interconnected model of professional growth depicts a mechanism by which these observations might initiate professional development in cooperating science teachers. Central to this model is attention to specific classroom outcomes. Thus, teacher attention has a role in filtering the observation experience and therefore has a role in directing professional growth.

Secondary science cooperating teachers are mentors that have unique opportunities to engage in professional experimentation because they observe within the context of their own classroom and because they watch topic relevant lessons enacted with their own students. The teacher noticing framework provides a tool that can be used to explore cooperating teacher attention and capture what specific outcomes they are attending to during their observations. It also helps to describe how the cooperating teachers are making sense of what they observe. With the renewed call for clinically-based programs (NCATE, 2010), the resource costs of providing such programs, and the opportunity for professional learning that serving as a cooperating teacher provides, further exploration into the specific experience of secondary science cooperating teachers is warranted.

Chapter Three: Research Design

Design Overview

This dissertation study was part of a larger three-year study focusing on the experiences of secondary science teachers serving as cooperating teachers for a nationally recognized STEM teacher preparation program. Specifically, this study asked the following questions: 1) What do secondary science cooperating teachers notice as they observe pre-service teachers enacting lessons in their classrooms? 2) Does the act of noticing stimulate reflection and pedagogical reasoning in the cooperating teacher? 3) What, if any, connection does the cooperating teacher draw between what they notice and their own teaching practices?

A critical first step to designing a research study is identifying the assumptions that drive the research design. Every study carries certain assumptions about the nature of reality (ontology) and the nature of knowledge (epistemology). These assumptions influence the theoretical perspective of the research, the methodology selected for the study, and the specific methods used to collect and analyze data. Figure 3.1 illustrates the relationship between the epistemology, framework, and methodology, as described in Crotty (1998), and applied to the design of the study. This chapter will address each of these layers in detail and describe how they relate to one another. In addition, this chapter will address the topic of researcher perspective, which invariably shapes the interactions between the researcher and the data. Finally, this chapter will address issues

of validity for this study.

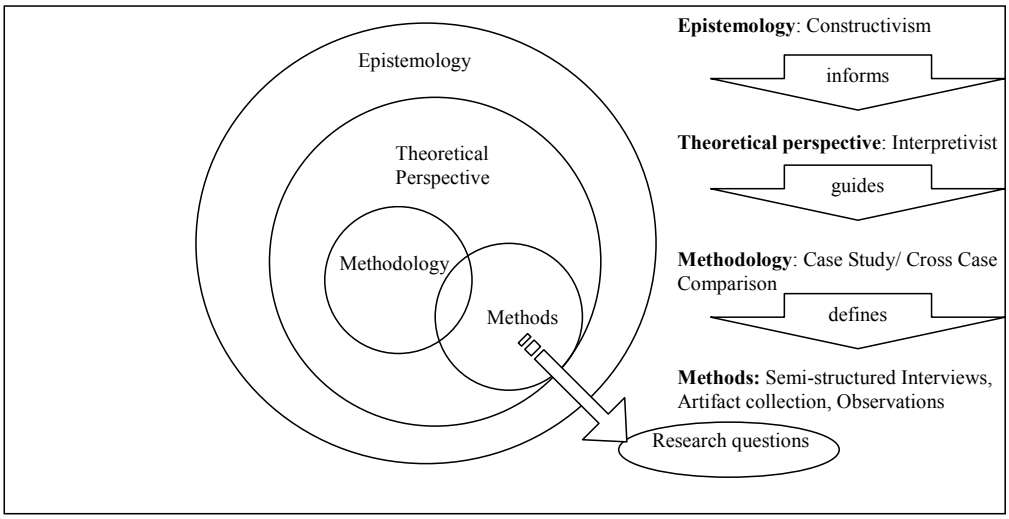


Figure 3.1. Research design that informs this study (Crotty, 1998).

Epistemology and theoretical framework.

Various views of the nature of knowledge exist. It is important to be explicit about the views adopted before embarking on a new research study and to make evident the alignment between the study assumptions and the research design. The epistemological stance underlying this study is one of Constructivism. This perspective suggests that meaning is subjective and is constructed through interactions with the outside world and through interactions with others (Vygotsky, 1978). Therefore, it is assumed that the participants in this study construct meaning from their experiences observing pre-service teachers in their classroom. It is also assumed that the researcher

constructs meaning from data during the process of analysis.

The theoretical perspective of Interpretivism also influences this study. This view adopts the stance that individuals seek to make meaning from their various experiences through the act of interpretation. This perspective is often attributed to Max Weber and the study of *Verstehen* or understanding (Elwell, 1996). This stands apart from a perspective of *Erklaren,* which seeks to explain. The perspective of interpretivism is useful for understanding how research participants will interpret and make meaning of events (Stake, 1995). The goal of studies driven by this perspective is to understand lived experience from the viewpoint of those involved. Therefore studies with this goal typically employ qualitative research methods with the aim of "learning how individuals experience and interact with the social world and the meaning it has for them" (Merriam, 2002, p. 4).

Methodology.

A methodology refers to a research tradition that seeks to answer specific types of questions and carries with it discrete approaches for data collection and analysis. Common qualitative methodologies include ethnography, phenomenology, biography, grounded theory, and case study (Merriam, 2002). This study employed the tools of qualitative case study as a way to capture the interpretations of the various participants. Case study methodology was selected because it allows for an exploration of participant perspectives and interpretations through "detailed, in-depth data collection involving multiple sources of information, rich in context" (Creswell, 1998; p. 61).

Case study.

The tradition of case study "allows investigators to retain the holistic and meaningful characteristics of real life events" (Yin, 2003; p.2). Yin goes on to describe several variations of case study design (see figure 3.2)

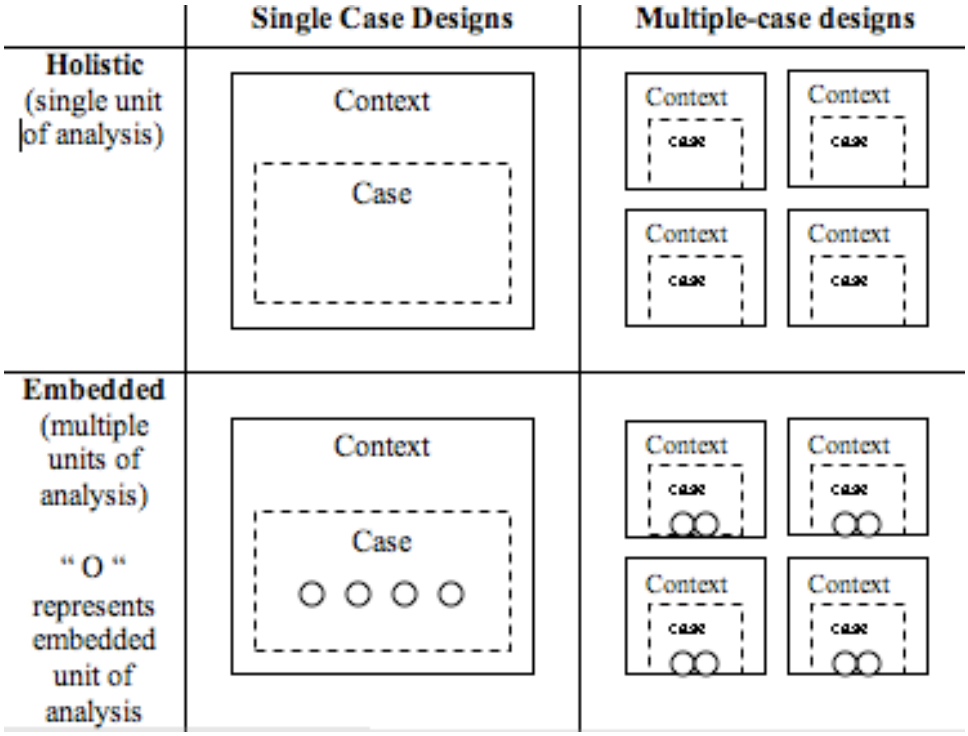


Figure 3.2. Variations of case design (Yin, 2003).

According to Yin, this dissertation study would be considered a single case study with an imbedded design. This framework consists of a broad case composed of several sub-cases. Yin likens the single case to a single experiment with the sub cases serving as trials. In this dissertation, the case study is designed to explore the experiences of the secondary cooperating teacher during an early field experience. As seen in figure 3.3, the

four different teachers in the study serve as sub-cases. This design is appropriate as it falls under Yin's criteria as a revelatory case because the secondary science cooperating teachers is an under explored group. The descriptive information provided by this case study will be useful in understanding the experiences of this group and may stimulate changes in the way university/school partnerships are viewed. Looking at four sub cases within this case lends power to findings and allows for the exploration of themes across the sub cases that might not be evident from investigation of a single cooperating teacher.

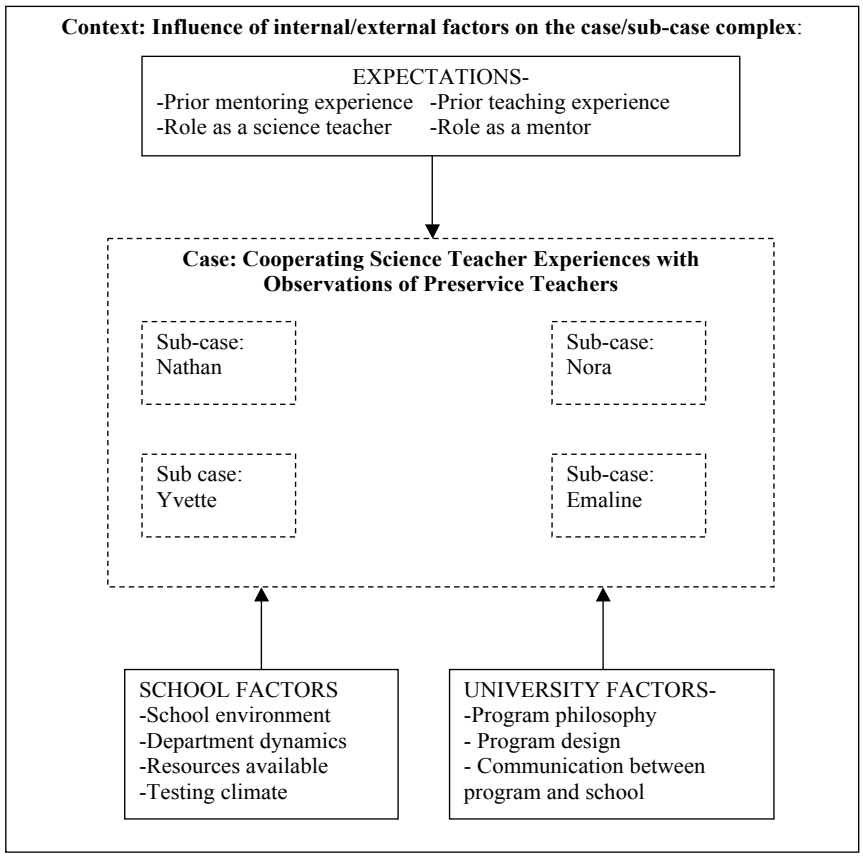


Figure 3.3. Case study design for this study

Note: Pseudonyms used to protect identity of participants.

Context: University factors.

A large public university developed the STEM teacher preparation program in this study. The program is grounded in constructivist principles and endorsed research-based best practices in STEM education. The inquiry-based teaching and active construction of knowledge promoted by the program have their roots in the works of Jean Piaget, Lev Vygotsky, and John Dewey. The program relies heavily on the 5E lesson model developed in the 1980's by the Biological Sciences Curriculum Study. This model includes the stages of Engagement, Exploration, Explanation, Evaluation, and Elaboration (Bybee et al., 2006). Pre-service teachers in the program are encouraged to use the 5E model or some variation of inquiry-based instruction in lesson planning and teaching.

Four courses in the preparation sequence include early field experiences prior to student teaching (see table 3.1). For purposes of distinction in this paper, students in the early field experience will be referred to as "pre-service teachers," not student teachers. During each of these courses, the pre-service teachers teach lessons throughout the semester in a cooperating teacher's classroom. For the first early field experience course, teaching takes place in elementary schools, during the second course pre-service teachers work in the middle school grades, and for the final two early experience courses the pre-service teachers teach in the high school setting. The program's culminating field experience is a 10-week student teaching episode where the pre-service teacher assumes

primary teaching responsibility for several secondary classes.

Table 3.1. Description of course sequence for teacher preparation program.

Early Field Experience 1	Three lessons over the course of the semester	Elementary setting
Early Field Experience 2	Three lessons over the course of the semester	Middle school setting
Early Field Experience 3	Three lessons over the course of the semester	High school setting
Early Field Experience 4	One long term project broken into several lessons taught during one part of the semester	High school setting
Student Teaching Practicum	Primary teaching responsibility for at least two classes over 10 weeks of the semester	High school or middle school setting

The field experience for this case study occurred as part of the course associated with Early Field Experience 3. This course uses an integrated approach to combine pedagogical skills with content knowledge in the STEM domains. The course provides pre-service teachers with various frameworks for creating high school lessons as well as analyzing their teaching practice. During the time of the study, the course used inquiry based teaching strategies, like the 5E model as well as generative design approaches (Stroup, Ares, & Hurford; 2004), as the basis for lesson design.

In this study, each cooperating teacher was a public high school teacher working with a pre-service teacher team (typically two students). The pre-service teachers taught a 90-minute lesson in the classroom of the cooperating teacher while the cooperating teacher observed the lesson being enacted with his or her students. The cooperating

teachers in this study worked with the pre-service teachers during a sequence of teaching events that occurred in their classroom over the course of a semester. During Early Field Experience 3 the cooperating teachers had limited face-to-face time with the pre-service teachers. They met together early in the semester for an introduction and orientation. The remainder of their interactions with pre-service teachers occurred via email, during the few minutes of preparation before the lesson was taught, and during the post debrief. The primary role of the cooperating teacher during Early Field Experience 3 was to observe the pre-service teachers in action and provide feedback as well as suggestions for improvement. Table 3.2 illustrates the sequence of events that accompanied each lesson during the field experience.

Table 3.2. Description of lesson sequence for early field experience

Pre Instruction	-The cooperating science teacher assigns a topic to be taught -The pre-service teachers develop a lesson (typically in pairs) -The pre-service teachers get feedback on lesson from university instructors as well as their cooperating teacher - The pre-service teachers revise the science lesson
Instruction	-The pre-service teachers teach a 90 minute science lesson -The cooperating teacher (a university observer may also be present) observes the lesson and completes a structured feedback form
Post Instruction	-The cooperating teacher and pre-service teachers debrief lesson (Typically 15-20 min) -The pre-service teachers are given written feedback from cooperating teacher and university observer

Context: School factors.

A large urban high school located in a high stakes testing state was selected as the study site. The school serves a diverse student population. 65% of the school's students are Hispanic, 22% are white, and 11% are African America. Less than 1% of students do not fit into one of these categories. 50% of the students served by this school are economically disadvantaged and 19% qualify as special needs students. At this school 8% of the teachers are in their first year of teaching, 37% have been teaching between 1-5 years, and 55% have been teaching 5 years or more (Greatschools.org, 2011). The study site was considered optimal because: 1) the student diversity and teacher quality were closely aligned with the state, 2) the researcher had a strong relationship with the teachers in the science department, 3) the school had been a consistent host for pre-service teacher placements, and 4) the majority of the cooperating teachers in the department had previous mentoring experience. This ongoing relationship promoted trust between the cooperating teachers, the teacher preparation program, and the researcher. This level of trust was beneficial for an intensive qualitative study that required a significant commitment from the cooperating teacher participants.

The six secondary science teachers who served as cooperating teachers at the start of the investigation period were informed about the study and invited to participate. Ultimately, the experiences of four teachers (Nathan, Emaline, Yvette, and Nora) made up the sub cases for the study. These teachers were selected because they were the only

cooperating teachers working with pre-service teachers for the entirety of the study. Table 3.3 describes each participant and their mentoring experience at the start of the dissertation study. Pseudonyms are used to ensure the confidentiality of participants and pre-service teachers.

Table 3.3. Participant descriptions

Cooperating Teacher	**Subject/s taught**	**Teaching experience (Yrs.)**	**Mentoring experience (Yrs.)**
Nathan	Chemistry/ Aquatic Science	13	4
Yvette	Biology/ Aquatic Science	9	7
Emaline	Chemistry	6	2
Nora	Chemistry/ Biology	3	2

The science department of the study site varied in size each year between 12-14 teachers depending on annual student enrollment. At the start of the study, the range of teaching experience was 4 to 15 years and all of the science teachers in the department had been teaching at the study site for at least three years. The department was divided into two wings. The physical sciences, including Chemistry and Physics, were housed in one wing while the life sciences were housed in another. Therefore, Nathan and Emaline had rooms next door to each other in the Physical Science wing, while Nora and Yvette taught in classrooms in the Life Science wing. The department had strong leadership and limited turnover. The department was divided into several course groups including Biology, Chemistry, Physics, and Aquatic Science. Teachers in each course group met

together once a week to discuss curriculum, pacing, and other course resources. In addition, the department met as a whole several times throughout the semester. The teachers in this department got along well and often ate lunch together while discussing the events of the day.

DATA SOURCES

The methodological tradition of case study carries with it an array of tools that can be used to capture information. Sources of evidence appropriate to this methodology are summarized by Yin (2003) and include interviews, participant artifacts, and observations. Given the research questions that guide this study, these data sources were employed to capture what secondary science cooperating teachers notice as well as how their noticing influenced reflection on their own practices for teaching high school science. This study included data collection from a total of five pre-service teacher lessons spread over three distinct teaching events. It is important to recognize that the three teaching events vary from one another in several ways. These events should be considered separate snapshots of cooperating science teacher noticing. For example, Teaching Event one was a two-day lesson taught during the fall of 2011. Lesson Events 2 and 3 were taught in the spring of 2012. Lesson event two consisted of a single lesson while lesson event three was a two-day lesson. And, the lessons in the fall were taught by a different set of pre-service teachers and in different classes than the spring lesson events. It should be noted that Emaline was present for only one teach during each of the two-day lesson events. Table 3.4 shows the timeline of data collection for this study.

Table 3.4. Timeline of data collection for participants

Nathan	**Teaching Event 1 (Two Days)**	**Teaching Event 2 (One Day)**	**Teaching Event 3 (Two Days)**
Pre Interview	11/10/11	2/16/12	3/29/12
Field Observation	11/14/11 11/16/11	2/29/12	4/2/12 4/4/12
Lesson Debrief	11/14/11 11/18/11	2/29/12	4/2/12 4/4/12
Artifact collection	11/14/11 11/18/11	2/29/12	4/2/12 4/4/12
Post Interview	11/17/11	2/29/12	4/5/12
Yvette			
Pre Interview	11/10/11	2/10/12	4/2/12
Field Observation	11/14/11 11/16/11	2/23/12	4/5/12 4/10/12
Lesson Debrief	11/14/11 11/16/11	2/23/12	4/5/12 *****
Artifact collection	11/14/11 11/16/11	2/23/12	4/5/12 4/10/12
Post Interview	11/17/11	2/24/12	4/13/12
Emaline			
Pre Interview	11/10/11	2/16/12	3/29/12
Field Observation	11/15/11	2/27/12	N/A* 4/4/12
Lesson Debrief	11/15/11	2/27/12	N/A* 4/4/12
Artifact collection	11/15/11	2/27/12	N/A* 4/4/12
Post Interview	11/15/11	2/29/12	4/5/12
Nora			
Pre Interview	11/10/11	2/16/12	3/29/12
Field Observation	11/14/11 11/16/11	2/22/12	4/2/12 4/4/12
Lesson Debrief	11/14/11 11/16/11	2/22/12	4/2/12 4/4/12
Artifact collection	11/14/11 11/16/11	2/22/12	4/2/12 4/4/12
Post Interview	11/17/11	2/24/12	4/12/12

N/A* - The cooperating teacher was not present but was at a conference on the date of the teaching event. Another teacher in the department sat in class for her.

***** This lesson debrief did not take place at the scheduled time and therefore was not able to be captured

Written artifacts.

Participant artifacts were collected in order to capture what the cooperating teachers were producing as a result of observation during the teaching event sequence. As a way to capture teacher noticing the cooperating teacher participants were given a data collection instrument, referred to as the noticing form, to record what stood out to them as they observed the science lessons being enacted in their classroom. This tool was designed to be open-ended and capture teacher noticing in real time. The noticing form was a personal record that was shared only with the researcher.

Additionally, as part of the requirement of the field experience, the cooperating teachers were asked to fill out a structured feedback form to give to the pre-service teachers. Copies of both forms are included in Appendix A. In a pilot of the methods for this study, cooperating science teachers reported being able to easily keep track of both documents during the observation process. In fact, one teacher reported that she liked using the noticing form in addition to the feedback form because it gave her an outlet for writing down the thoughts that were not appropriate to share with the pre-service teachers.

Both the noticing form and the feedback form completed during each teaching event were collected, scanned, and labeled with the appropriate time and date. Identifying information was immediately redacted. The noticing form was not used as direct evidence of teacher noticing since teachers often wrote incomplete thoughts or used

shorthand and the teacher's intended meaning might be misinterpreted. Instead teachers were asked to use the noticing form as a guide to talk about what they noticed during the post lesson interviews.

Personal Interviews.

To collect background and experiential information from the cooperating teachers participating in the study, semi-structured interviews were conducted both before and after the teaching event. The purpose of the interviews was to have the teacher describe and explain the content of their noticing. A semi-structured interview involved predetermined questions that addressed the research goals. These questions were presented in an order and language appropriate to participants in the study (Berg, 1998). A sample of the questions asked is presented in table 3.5. When needed, the researcher went beyond the predetermined questions in order to gain a more in-depth understanding of a particular response.

Table 3.5. Semi-structured interview questions

Context Questions	• Describe your teaching experience. How many years have you been teaching? Which subjects do you teach? • What do you see as your role as a science teacher? • Tell me about your experience working with pre-service teachers. How many years have your been doing it? What kinds of experiences have you had? • How do you see your role in the classroom when the pre-service teachers are teaching their science lesson? • In the past, when you have observed pre-service teachers teaching science lessons in your classroom what has stood out to you?
Pre-instruction Interview Questions	• What is on your mind with respect to your teaching right now? • From looking at the lesson plan, what have you noticed so far about the lesson you are going to observe? (What are you interested to see?) • How do you think it is going to go? (Follow up – what are you expecting to go well? What do you think there will be challenges with?) • Where in your lesson sequence does this science lesson fit? • Is there anything else you would like to add?
Post-instruction Interview Questions	• Please describe the science lesson you saw. • What did you identify as important or noteworthy about the lesson? • Can you tell me more about why each of these events stood out as important to you? • Which, if any, of the things you noticed connect to your own science teaching? • What, if any, changes to your teaching are you planning as a result of this observation? • What learning experiences come next for your students? • Is there anything else you would like to add?

Pre-instruction interviews lasted between 20-30 minutes while post-instruction interviews spanned 40 minutes to 1 hour in length. The pre-instruction interview

occurred no sooner than a week before the teaching event and post-instruction interviews were conducted as soon as possible after the teaching event (see table 3.4). The timing of the post interviews was dependent on the schedule of the cooperating science teacher. During the post interviews the teachers were provided with their noticing form as well as their feedback form for reference. All interviews were digitally audio-recorded and transcribed.

Lesson debriefs.

Lesson debriefs occurred after each teaching event. These were composed of conversations between the pre-service teachers and the cooperating science teacher. These conversations varied in length based on the schedules of all parties. The approximate time for a typical lesson debrief was 15 minutes though the range was between 10 minutes and 40 minutes. These debriefs were recorded as a way to gain insight into the noticing instances that the cooperating teacher chose to share with the pre-service teachers. During the lesson debriefs a digital recorder was left in the room but the researcher was not present. Lesson debriefs were also transcribed and identifying information redacted.

Observations.

Another data source for this qualitative case study came from field observations. The researcher observed the secondary science cooperating teachers in this study during

the instructional portion of each teaching event. The purpose of the observation was to create a record of what the cooperating teacher was doing while watching the lesson. Observations were a minute-by-minute recording of the cooperating teacher's actions as they watched the lesson. This included comments they made, the amount of time spent writing on the feedback or noticing form, and observations of their body language. A sample field observation is included in Appendix A. A field note summary of each observation was created within 8 hours of the teaching event. Each summary was labeled and an electronic copy was placed into the appropriate participant folder.

DATA ANALYSIS

Data analysis began at the start of the study and continued throughout. Transcripts from the teacher interviews and recorded lesson debriefs composed the main sources of data. Data from written artifacts and field observations were used to support comments made during interviews and lesson debriefs. The data sources were analyzed together (Stake, 2005) the various data sources were used to crystalize the findings (Tracy, 2010).

The data analysis was an opened ended process where themes and categories emerged from participant responses. Lincoln and Guba suggest that, "data analysis involves taking constructions gathered from the context and reconstructing them into meaningful wholes" (1985, p. 333). A constant comparative method (Glaser & Strauss, 1967) was used to compare the data sources. This constant comparative analysis was recursive. The initial findings acted to inform subsequent data collection and analysis thereby modifying the progress of the study.

There were four stages in the data analysis process. The first stage was to organize the data during the collection process. For interviews and lesson debriefs the organization scheme included an initial listening of the recordings in order the gain a holistic picture of the exchange. During this time the researcher took notes and wrote down questions that related to the topic being discussed on the recording. Every interview and lesson debrief was then transcribed. The transcripts were numbered by line and research notes were inserted as comments when questions or possible themes arose. Organization of artifacts and field notes included electronic scanning of the document, immediate redaction, and holistic review. As with the recordings, these data sources were reviewed for initial impressions and notes were written. All data was labeled with participant pseudonyms, time, date, and stored electronically in participant folders.

The second stage was to identify a unit of analysis. Erlandson et. al. (1993) assert that a unit of analysis is the smallest piece of data that can stand on its own. This may be a few sentences, a key term, or a heuristic element in the data. As units of analysis were determined, they were coded and defined. For purposes of this study, the unit of analysis will be referred to as a noticing instance. Noticing instances were distinguished by dividing cooperating teacher comments into idea units (Grant & Kline, 2004; Jacobs & Morita, 2002). A noticing instance was identified when a cooperating teacher mentioned a noteworthy observation. The noticing instance included this noteworthy observation as well as any related comments. A shift in topic was the signal of a new idea unit and therefore the start of a new noticing instance. All noticing instances were identified for each of the transcribed interviews and lesson debriefs.

The third stage of the analysis involved developing emergent themes. This included organizing noticing instances into themes that developed as the data was classified and organized. It is important to recognize that these themes are a creation of the interaction between the researcher and the data and represents only one of many possible coding schemes (Lincoln & Guba, 1985). As themes emerged, the ideas developed during initial review of the data were assigned a code. The researcher then went back to the data sources and coded for instances of the different ideas in order to capture themes. Blind checks (Zeineddin & Adb-El-Khalick, 2010) were conducted with four additional researchers at various points during the analysis process. Random sections of transcribed data were independently coded and any discrepancies were negotiated as a way to clarify and strengthen the coding scheme.

The fourth stage of analysis was to consider counter examples. This involved paying attention to examples that did not fit with initial themes. By addressing data that run counter to themes, one can show the complexities of the data collected (Creswell, 1998). After refinement and analysis the final coding scheme included two domains, noticing content and noticing structure. Each noticing instance was first categorized by the topic that was the focus of the noticing. A list of topics is provided in Table 3.6.

Table 3.6. Noticing content

Noticing Topics	**Includes references to:**	**Example**
Student understanding of science content	Student misconceptions, Evaluation of student progress on a specific science concept	When Jake was presenting, I could tell he really didn't understand the concept of valence electrons. He was struggling there.
Student engagement/ participation	Student engagement, Student participation in various parts of the lesson, Participation of individual students	I saw that during the warm up my kids were extremely off task; only two or three were actually paying attention to them.
Pre-service teacher (PST) characteristics	Specific characteristics of the PST personality or demeanor	He (the PST) seemed nervous when he was in front of the kids teaching
Student characteristics	Student attendance, student well being, general personality traits	Thomas really seemed to be helping. I haven't seen him act as a leader before.
Lesson structure and implementation	Lesson design and/ or the lesson plan, the sequence of lesson activities, the 5E model	The exploration section of the lesson seemed more like an explanation. The kids weren't really exploring anything.
General pedagogy	General pedagogical skills including classroom management, grouping, time management, and instruction giving	They did a good job with circulating around the room during the lab.
Questioning and Assessment	Question appropriateness, question structure, question content, strategies for assessing students	They seemed to ask a lot of short answer questions. I would have like to see them do more probing.
Representation of science content	Attention to science content or to the specific strategies and representations used to present the content.	His description of the Hess's Law was incomplete. I was interested in the applet he was using to show the effect of concentration. It gave students a chance to look at a lot of different variables.

Once the topic of each noticing instance was identified, the structure of the noticing instance was then analyzed. Three noticing elements, evaluation, interpretation, and transformation, were used to describe the structure of each noticing instance. The noticing elements are listed in Table 3.7. It should be noted that the structure of a single noticing instance often included more than one noticing element.

Table 3.7. Noticing structure

Noticing Elements	**Description**	**Example**
Evaluation	The teacher makes a value judgment about the noticing	I liked that they were using models to show the structure of DNA, I thought that was really good.
Interpretation	The teacher provides and explanation for the something they notice or describe why it has importance	I saw they we using models to show the structure of DNA. This helps student figure things out and it helps them understand it.
Transformation	Teacher suggests specific actions to transform the lesson based on the noticing	I saw that they were using models to show the structure of DNA. They should have given students a 3D model instead of the one on paper.

As a result of the data analysis a detailed portrait of each teacher and their noticing was created. These individual cases were analyzed "through direct interpretation of individual instances and through the aggregation of instances" (Stake, 2005) in order to create a rich picture of the noticing experience.

In addition to creating individual-participant cases, this study looked for sub case correspondence. In this method of analysis, findings were combined across the various participant sub cases in order to look for consistencies in the data (Stake, 2005). The reason for this type of synthesis was to highlight trends and reveal common thoughts, behaviors, and patterns that provide insight into the larger case. These trends added significance and provided more powerful explanations than findings from a single participant (Miles & Huberman, 1994). The coding themes, cases, and areas of sub case correspondence were peer examined and member checked for credibility (Merriam, 2002) as a way to ensure appropriate representation of the data.

PERSPECTIVE AND VALIDITY

Any robust study must address issues of researcher perspective and validity. As this study is a qualitative case study, it should be recognized that though the analyses are based on the data, the findings that arise are the result of an interaction with the data that is influenced by the particular social and cultural perspectives of the researcher. It should therefore be noted that this study emerged as an intersection of interests stemming from the researcher's experience as a former secondary science teacher, a mentor of pre-service teachers, and her current role as a teacher educator working with pre-service teachers. The researcher was at one time a science teacher at the study site and knew several of the participants prior to the start of the study. This collegial relationship may have influenced participant responses. Perhaps the teachers felt pressure to answer interview questions in a specific way, though the open-ended nature of the questions and

the specific examples provided by teachers make this scenario unlikely. On the other hand, this relationship may also have facilitated the cooperating teachers feeling free to share their insights about the science lesson during the observation process with someone they trusted.

Tracy (2010) suggests several criteria that can be used as markers of quality in qualitative research. These include research that addresses a worthy topic, is rich in rigor, is sincere, and is credible. Table 3.8 describes how this study addresses each of these factors.

Table 3.8. How this study meets standards for quality

Objectives to ensure quality of study (Tracy, 2008	**Strategies employed by this study to meet objectives**
Counterintuitive *Makes an interesting rather than an obvious contribution*	-It is widely accepted that pre-service teachers learn from cooperating teachers but the opposite is a comparatively new idea -That cooperating teachers learning from pre-service teachers in a secondary science setting is a relatively novel concept
Rich Rigor *Includes the amount of data collected and time in the field;* *Complex and varied data sources;* *Thick and detailed descriptions*	-This study was part of a larger study on cooperating science teacher learning that has been underway since 2009 -Data was collected at various points throughout each teaching event -A variety of data sources and artifacts led to thick descriptions of cases
Sincerity *Researchers are self reflective about the perspectives they bring;* *Study is transparent about the methods and challenges*	-Researcher perspective is acknowledged -A detailed description of the method employed in the study is included
Credibility *Triangulation;* *Study uses multiple data sources to provide a more thorough understanding for the topic;* *Member reflections*	-Data collection included a way to capture what teachers said, did, and created during the teaching event -Findings were presented to and checked by members to ensure an appropriate representation of their perceptions

This dissertation study considers a worthy topic, is transparent about the perspective of the researcher, and uses complex and varied data sources, as well as member reflections, to provide a comprehensive understanding of the cooperating teacher's experience.

In summary, this chapter has attended to the relationship between the epistemological assumptions, the theoretical framework, and the research design that underlie this study. It has made a case for the appropriateness of case study methodology in addressing the research questions under investigation. Furthermore, this chapter has provided a detailed account of the data sources collected and the methods employed to analyze the data. Finally, this chapter has discussed the issues of researcher perspective and validity as they relate to this dissertation study.

Chapter Four: Results

The purpose of this study was to describe and characterize the nature of cooperating science teacher noticing as they observed pre-service teachers enacting lessons in their classrooms. Specifically, the study asked three questions: 1) What do cooperating science teachers notice as they observe, 2) does the act of noticing stimulate pedagogical reasoning in the cooperating teacher, and 3) what, if any, connections do teachers draw between their noticing and their own teaching practice? This chapter provides information about each of these questions in turn. To answer question 1, the chapter begins with a review of the cases for each of the cooperating science teachers. The chapter goes on to report trends in the content of teacher noticing. To answer question 2, the chapter next discusses the elements of noticing structure and implications for teachers' pedagogical reasoning. Finally, to answer question 3, the chapter describes teacher noticing in relation to the connections teachers draw to their own practice.

THE CONTENT OF COOPERATING SCIENCE TEACHER NOTICING – SUB CASES

The following section is organized into four individual cases followed by a cross case analysis. The data for this section comes primarily from lesson debrief and interviews. Noticing forms and field notes from classroom observations served as supporting evidence for teacher comments. The cases provide background information, describe the lesson events observed, and provide an account of what teachers notice during each event. The content of teacher noticing within each case is organized into

noticing topics and the frequency of noticing instances within each topic is discussed. As a way to describe the data, this study classifies topics accounting for at least 20% of noticing instances as areas of primary focus. Topics accounting for at least 10% of noticing instances are considered areas of secondary focus and topics accounting for less than 10% of noticing instances are considered areas of limited focus. Topics that were not noticed are also discussed. Trends found in analysis of the four cases are presented in the cross case analysis. It should be noted that teacher noticing exists on a continuum with a range of attention. The categories of primary, secondary, and limited focus have been established as a way to categorize and discuss the findings and do not always represent obvious breaks in the noticing data.

NATHAN

Nathan's Profile.

Walking into Nathan's classroom, science equipment and materials can be seen scattered around the somewhat cluttered room. There are posters of scientists and scientific vocabulary along with a few pictures of local musicians. Nathan is in his late thirties, a guitarist, and a recent father. He is a veteran teacher who has been teaching science for 12 years. Nathan majored in Biology and minored in Chemistry in college and he had recently completed his Masters degree in Science Education. He is certified to teach all science courses. At the time of the study, he was teaching Earth Space Science and it was his first time teaching Chemistry in several years. The students in his classes

ranged in age from sophomores to seniors.

Nathan's interviews revealed that he sees his role as a science teacher as someone that is responsible for teaching students science content and being sure they know more about science when they leave his classroom than when they came in. He also described feeling responsible for teaching his students the social skills that will help them to be successful in their work with others. Additionally, he mentioned remaining flexible to the needs of students at different ability levels and well as the need to be flexible when working with colleagues.

Nathan views his classroom as a place where he can model the scientific process for his students. In describing an ideal science lesson Nathan said, "Ultimately it's when you're doing good science and you're modeling the scientific process. The kids are creating hypotheses about observations that they've made about some phenomenon and they're testing them, using either their own experimental design, or some kind of experimental design that you've come up with to help structure the learning" (Nathan, Pre Interview, Nov. 2011). He mentioned that he likes to use the 5E lesson model because it starts with getting students engaged in the content. He also described himself as a constructivist, which to him means allowing students to shape their understanding from the experiences he provides. However, he again mentioned that he finds this type of instruction to be a challenge because he feels that students need to "be at a certain level" with the math or science content to be successful. Lastly, he described some science lessons as opportunities for his students to practice science skills like performing calculations and using scientific equipment appropriately.

At the start of the study Nathan had four years of experience working as a cooperating teacher. He had worked with several local teacher preparation programs. He had hosted student teachers as well as pre-service teachers participating in early field experiences. Nathan reported viewing the experience of the pre-service teachers in his classroom as similar to the trial and error process someone would encounter working through the scientific method. He described his thoughts saying, "This is an opportunity, this is a practice, much like the Scientific Method, right? Did what [the pre-service teacher] expected happen? If it didn't go the way they wanted it to, what could they do to change it?" (Nathan, Pre Interview, Nov. 2011) He felt that his role during this process is to be an observer that can provide direction about things the pre-service teachers might do differently as well as suggest ideas they may not have considered. He said that he wanted to help them learn to grow from a "baseline" understanding of teaching, especially in the area of classroom management.

Nathan's characteristics as an observer.

Field notes reveal that Nathan was actively engaged in the observation process. During a 90-minute period Nathan on average spent 83 minutes actively writing observations, listening, or moving around the room to watch the lesson. On average seven minutes were spent on other tasks such as answering the door, taking attendance, or writing out restroom passes. Nathan typically sat at the back of the classroom during whole class portions of the lesson. During group work or lab activities he circulated through the room to listen to and watch students. He did not integrate into the groups but

remained on the out skirts. He was a passive observer throughout, responding only when a student asked him a direct question.

Though Nathan was provided with both an open ended noticing form and a structured feedback form he chose to focus solely on the noticing form during the lesson. He would write a free form narrative of the things that he noticed from the lesson. At then end of the lesson he would spend a few minutes transferring comments to and checking boxes on the feedback form. He used his noticing form as a guide when debriefing with the pre-service teachers and he gave them the feedback form for their records. Recordings of these interactions reveal that his comments were supportive as well as constructive and at times included references to literature such as the writings of Piaget and Vygotsky.

During the period of the study Nathan hosted two different pre-service teacher teams. The two teams each taught three 90-minute lessons in his classroom. The first team lessons covered the topics of electron configuration and bonding during fall 2011. The second team covered the topics of thermochemistry (Hess's law) and properties of water during spring 2012. During each lesson Nathan watched each team and gave them feedback. The following section of this case will describe Nathan's noticing by lesson event as well as his noticing trends.

Nathan's noticing by lesson event.

Lesson event one.

The first lesson event observed by Nathan was a two-day lesson that occurred on

November 14 and 16, 2011. A pair of pre-service teachers taught this lesson to a morning Chemistry class. The topics covered were electron configuration and ionic and covalent bonding. The main lesson activities for day one included a warm up and lecture by the pre-service teachers, a short group activity where students analyzed the electron configuration of elements on a periodic table, and then a return to a whole class lecture. On day two, the lesson began with a warm up and lecture. The students in the class were then asked to complete a worksheet to practice Lewis Dot structures individually. This was followed by a group activity where students were asked to create posters comparing Lewis Dot structures and the Bohr model. The students then presented their posters to the class while the rest of the class served as the audience. The lesson was concluded with a short whole class lecture and question and answer session.

During lesson event one, Nathan's noticing instances were concentrated into three areas of primary focus: Student understanding (29% of noticing instances), representation of science content (20% of noticing instances), and general pedagogy (21% of noticing instances). The secondary noticing categories in this lesson included lesson structure and student engagement. The remaining categories of questioning, student characteristics, and pre-service teacher characteristics were each mentioned in 5% or less of noticing instances.

During the first lesson event Nathan paid the most attention to student understanding. 29% of Nathan's noticing instances during event one fell into this category. Given that the lesson had students describing their understanding through poster presentations there was ample opportunity to attend to this topic. Figure 4.1 shows

the percentage of Nathan's noticing instances by topic during Lesson event one.

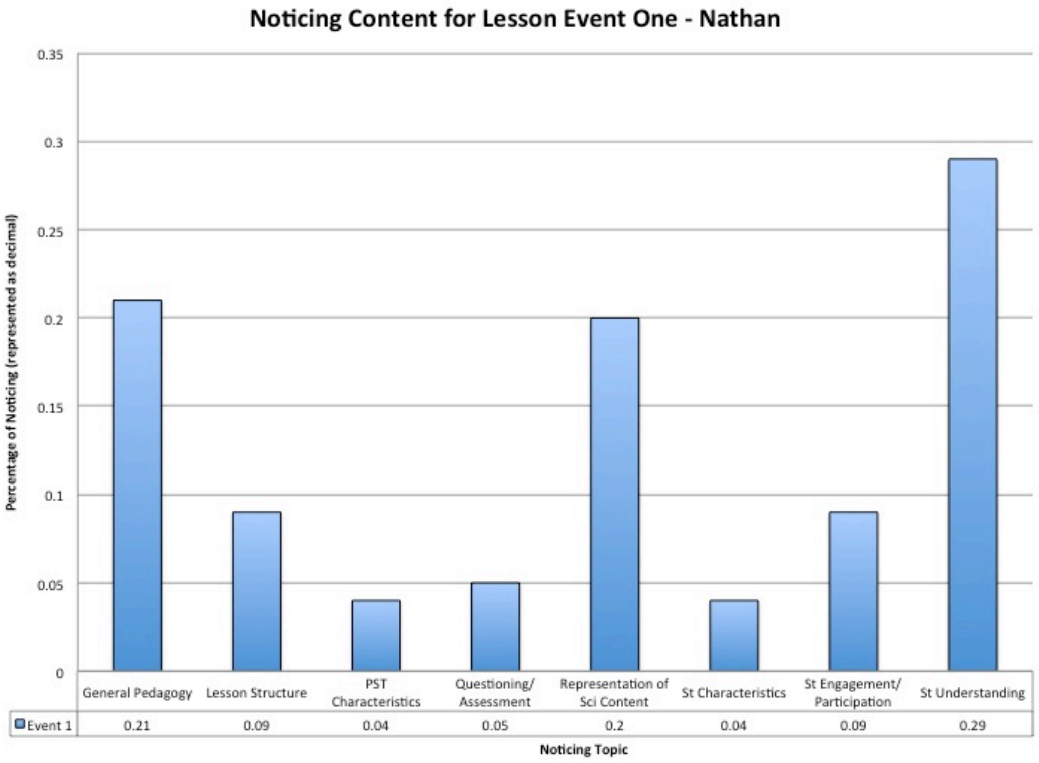


Figure 4.1. Nathan's noticing content for lesson event one

He also paid attention to the ways in which the concepts of bonding were being presented to his students. For example, when communicating with the pre-service teachers about the lesson, Nathan's comments show evidence of his noticing in both of these categories. For example, in his lesson debrief for day 2 Nathan communicated his thoughts in this area. He said,

> The posters were good evidence that the students were able to link prior knowledge to new knowledge which is really what we are trying to do. Seeing

> that the actual electron configuration was in the periodic table reinforced the idea that the patterns increase or change as they go across and it really helped [the students] as they filled out the electron configuration. There wasn't a single poster with incorrect configuration. That's amazing; it's a difficult topic. You don't normally see that. Normally when I do it I get lots of kids scratching their heads and I have to hit the drawing board the next day (Nathan, Lesson Debrief 1, Nov. 2011)

Another example comes from the lesson debrief. Nathan made a comment that included instances of noticing both presentation of the content and student understanding saying,

> You used an excellent analogy when no one could tell you about covalent bonding. I don't know if you planned that but the thing about textbooks was something they understood. The a-ha moment went on for most of them with that" (Nathan, Lesson Debrief 1, Nov. 2011).

He echoed his attention to this event during his post interview when he said, "One of the things that Rene did was teach by analogy almost exclusively, when the kids were really struggling with the molecular bonding, she said, 'What if you have ten textbooks but you have eleven students? What happens? Well one of them has to share.' And the kids were able to kind of get it by being able to reference what was going on." (Nathan, Post Interview, Nov. 2011)

He also attended to the way in which the pre-service teachers signified orbital notation and the impact it had on his students. During the post interview he said,

> Another observation I had from moving around was the shorthand notation using the noble gas where (the pre-service teachers) took an entire chunk of the orbital notation and replaced it with a noble gas because it was kind of a shortcut. And Marcus seemed to really understand that, and he was able to explain it to the other kids in his group (Nathan, Post Interview, Nov. 2011).

In addition to student understanding and presentation of science content, Nathan also attended to the pedagogical moves made during the lesson. He noticed elements of the lesson having to do with the organization of materials, the timing of the lesson, and grouping. Comments during the lesson debrief show that Nathan also attended to the way that the instructions were given during the lesson. He said,

> You gave a specific set of instructions even though some didn't right down the instructions. I think when you are going through a lecture specifically telling them what you want them to write down – what you want them to know. You have to be explicit. This at least gets them involved in writing down (Nathan, Lesson Debrief 1, Nov. 2011)

Lesson event two.

Event two was a one-day lesson that occurred in an afternoon Chemistry class on February 29, 2012. The lesson was taught by a single pre-service teacher and the topic for the lesson was comparing endothermic and exothermic reactions. The lesson began with a warm up and lecture. The students then reviewed some chemistry vocabulary through a

quiz and trade activity. After several rounds of quizzing and trading vocabulary words with other students, the class watched a video introducing the concepts of endothermic and exothermic reactions. The students then worked in pairs on a computer simulation exploring various chemical reactions and determining whether they were endothermic or exothermic. Finally, the class ended with the pre-service teacher describing the simulation findings to the class.

In contrast with his noticing from lesson event one, Nathan focused less on student understanding during the lesson event two. During lesson event two only 5% of his noticing fell under this topic. Instead of focus on student understanding, the primary focus of Nathan's attention for lesson event two was on general pedagogy. Secondary focus areas included representation of science content, student engagement, and questioning and assessment. This represents a stronger focus on the topic of questioning and assessment when compared with lesson event one. The rest of the noticing instances in lesson event two are sprinkled across the remaining noticing topics with the exception of lesson structure. There were no noticing instances in the area of lesson structure during this lesson event. Figure 4.2 shows Nathan's noticing content for this event.

Nathan continued to focus on presentation of science content during lesson event two. This noticing topic accounted for 24% of his noticing during event two. For example, his comments to the pre-service teacher after the lesson show Nathan attending to the way the computer applet was being used to support the concepts on endothermic and exothermic reactions.

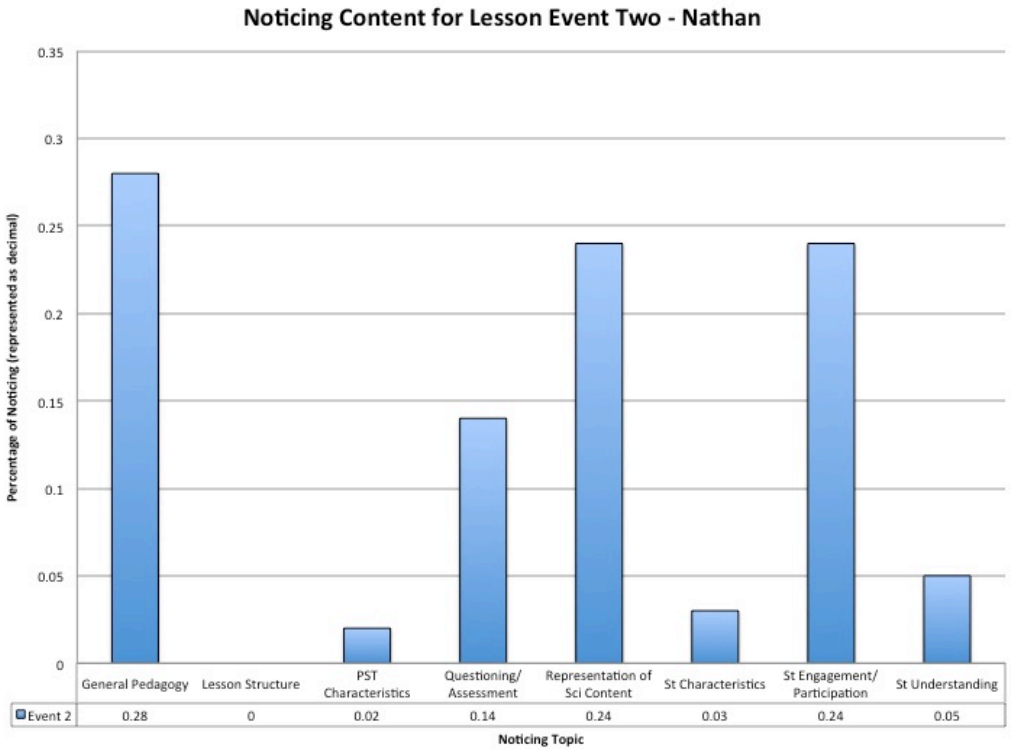


Figure 4.2. Nathan's noticing content for lesson event two

He said,

> I like that you referred to the vocabulary as you explained the computer applet. Could you have had students explain the applet? Have them pull it up on the screen and say 'show me why it is exothermic – point it out in the graph, how can you demonstrate an exothermic reaction?'(Nathan, Lesson Debrief, Feb. 2012).

He also maintained an attention to general pedagogy during event two. One instance of noticing general pedagogy comes from the post interview. When describing what he noticed about the lesson event two Nathan said, "I wanted to see clearer modeling of expectations when he was setting up the activities. Before going into one

thing, have one student explain the instructions." (Nathan, Post Interview, Feb. 2012). Nathan also noticed the pre-service teacher's grouping strategies and time management.

Nathan's focus on questioning and assessment was a marked difference between his noticing during lesson event one and event two. In event one this topic accounted for 5% of Nathan's noticing. This was increased to 14% in lesson event two. Nathan's comments during the lesson debrief for event two illustrate his attention to questioning. In debriefing with the pre-service teacher he suggested,

> Press students for why instead of just telling them. I noticed that you often told them the answer. That is kind of a novice thing. Try to break it down using questions – what did you notice, what happened to the temperature? Science is a lot of deductive reasoning (Nathan, Lesson Debrief, Feb. 2012).

This comment illustrates that Nathan was paying attention to the kind of questions that the pre-service teacher was asking and the way he responded to the students. He echoed this noticing during his description of the lesson in the post interview. Nathan commented,

> I just really wanted to see more questioning, and I noticed there were a lot of points in the lesson where he would ask a single question, and then when he didn't get an answer…he gave wait time, which is good, but if he didn't get the answer the gave them the whole enchilada right after that, instead of asking them smaller questions to lead them (Nathan, Post Interview, Feb. 2012).
>
> This set of comments is typical of Nathan's attention to questioning during lesson event two.

Lesson event three.

The third lesson event Nathan observed was a two-day lesson occurring on April 2 and April 4, 2012. This lesson was taught by the same pre-service teacher to the same group of students as lesson event two. The topic for both days of the lesson was investigating properties of water. The structure of the two days was similar. On both days the students were given a pre-assessment on the topic in the form of warm up questions. The students spent the majority of time on both days working on a stations lab where they explored different properties of water. The stations on day 1 explored the properties of polarity and the structure of the water molecule. On day 2, the lab stations focused on properties of water such as adhesion, cohesion, surface tension, and density. Both days ended with the pre-service teacher reviewing the lab findings with the students and delivering a short lecture to the class.

The content of Nathan's noticing instances during event three was similar to event two. The areas of general pedagogy, presentation of science content, and student engagement remained areas of focus. There is also continued attention to questioning and assessment during lesson event three. The remaining noticing instances for event three fall into the four topic categories with lesson structure and student understanding having slightly more focus than pre-service teacher and student characteristics. Figure 4.3 displays the content of Nathan's noticing during Lesson event three.

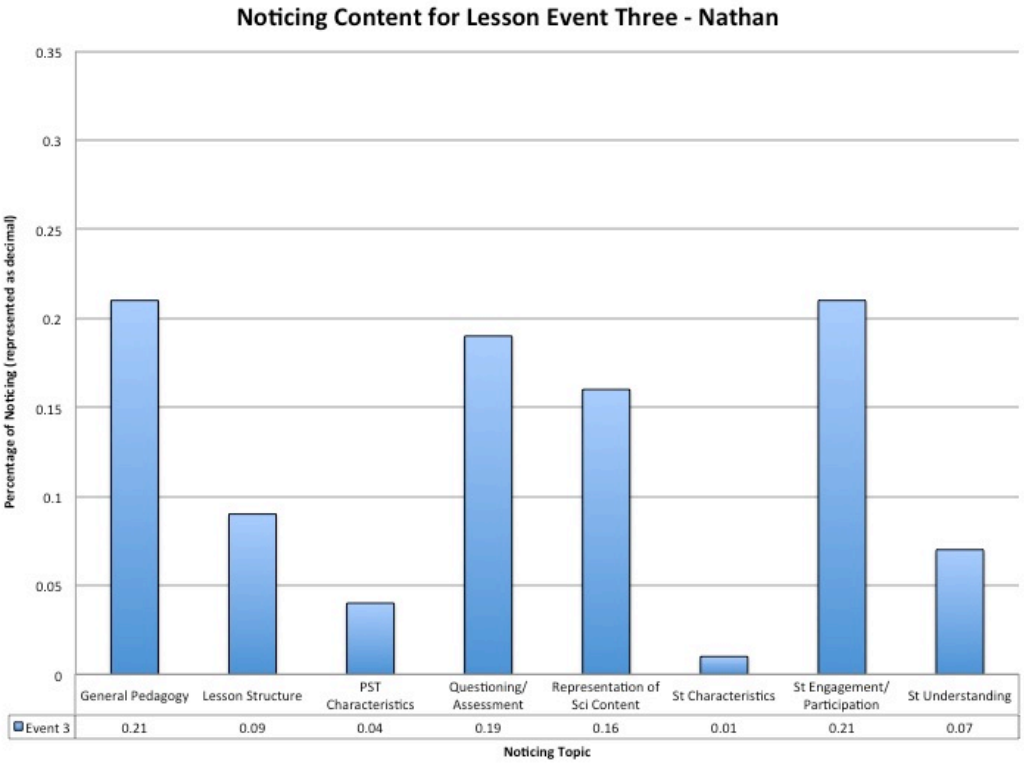


Figure 4.3. Nathan's noticing content for lesson event three

In reviewing the water station lab activity with the pre-service teacher, Nathan made a comment that illustrated his continued attention to the science content. In describing what he noticed while observing one of the lab stations he said,

> It was tough (for them) because you have the soap being amphipolar – one end it is not, one it is. Maybe using an analogy would have helped. I was thinking about things that are combination tools like one end is one thing and one end is another. Like a swiss army knife, one end is this, another is that or one of those spatulas. One end will do one thing the other the other. It hooks them together (Nathan,

Lesson Debrief 2, April. 2012).

Not only did Nathan attend to the content of the lab but he also spent time thinking about alternative ways to present it to his students.

Lesson debrief comments also illustrate that Nathan maintained a focus on general pedagogy as well as student engagement. A comment that illustrates both of these noticing topics was made when Nathan was discussing the way that the pre-service teacher chose to pair up the students in the room. He said to the pre-service teacher,

> In the warm up you had students working in pairs…oh this is something …a management thing. Sometimes it is ok, I do this too, to say ok work in pairs. But if you have an odd number you have to pair them because if not then the extra kid will sit there and that is what Ivan did. He sat there disengaged and not listening. Sometimes students can feel like you are not concerned about them (Nathan, Lesson Debrief 2, April. 2012).

In this comment Nathan used a noticing about student engagement to explain something else he noticed about the grouping strategy used by the pre-service teacher.

Nathan's continued focus on questioning is also evident from the noticing data. In the lesson debrief for event three he praised the pre-service teacher for his improvement in this area saying,

> I noticed from group to group the questioning strategies were really good. This takes the questioning strategy to the next level. It seemed that you had a verbal member for each group. What could you have done to get more students involved? (Nathan, Lesson Debrief 2, April. 2012).

This attention to questioning and assessment was reiterated during the post interview when Nathan mentioned that, "I guess going backwards to the second day, (the pre-service teacher) was asking really, really good questions. 'Why doesn't the oil mix with the soap?' They were really good leading questions to try to get them at what's going on." (Nathan, Post Interview, April. 2012)

Nathan's noticing trends.

A picture of Nathan's noticing over the three lesson events is presented in Figure 4.4. The graph shows the percentage of total noticing within each noticing topic for lesson events 1, 2, and 3. Overall, the topics of general pedagogy and representation of science content maintained high levels of attention for Nathan across events. Noticing instances within these two areas were areas of primary or secondary focus in all of Nathan's noticing data.

In a similar fashion, the noticing topics of lesson structure, pre-service teacher characteristics, and student characteristics received little of Nathan's attention regardless of the lesson event being observed. Less than 5% of his attention was focused on these topics during the course of the study. The amount of attention focused in the other noticing categories varied by teaching event. Questioning and assessment was a topic of greater focus during the spring semester (lesson events 2 and 3) than during the fall.

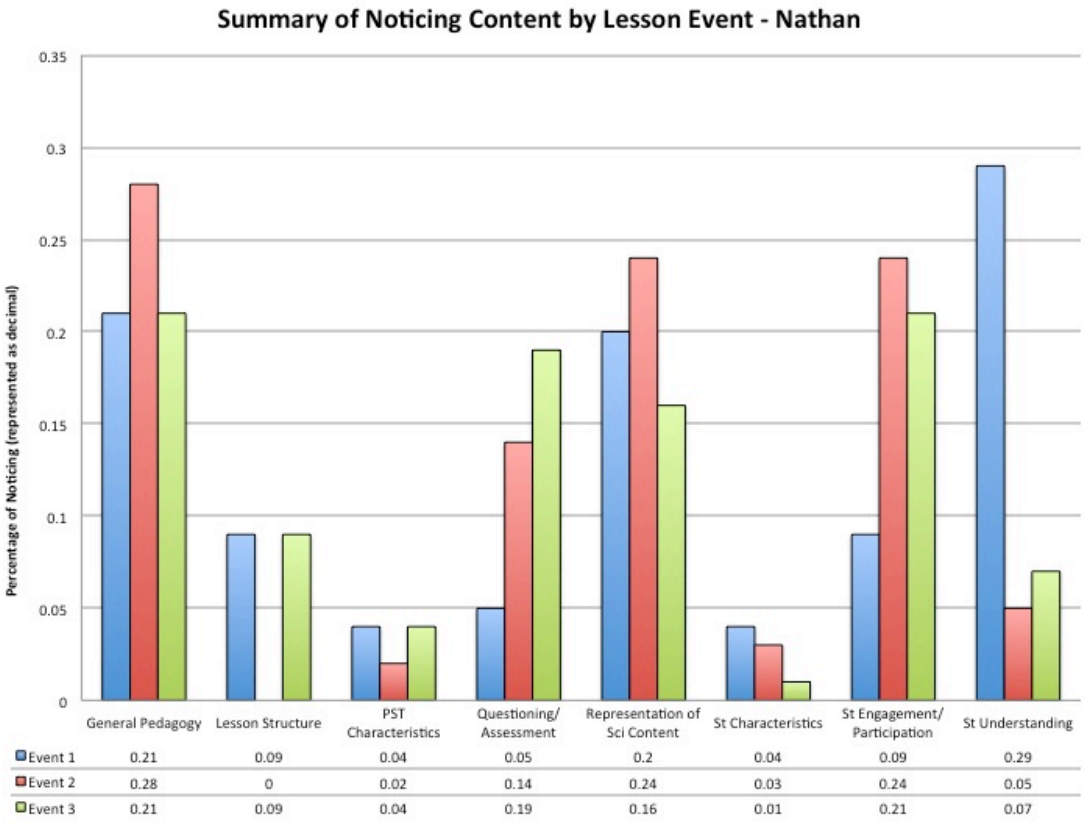


Figure 4.4. Summary of Nathan's noticing content by lesson event

Table 4.1 provides a summary of Nathan's focus areas by lesson event.

Table 4.1. Nathan's noticing by areas of focus across lesson events

Focus	Lesson Event 1	Lesson Event 2	Lesson Event 3
Primary	General Pedagogy Science Content St. Understanding	General Pedagogy Science Content St. Engagement	General Pedagogy St. Engagement
Secondary		Question/Assessment	Question/Assessment Science Content
Limited	Lesson Structure PST Characteristics Question/Assessment St. Characteristics St. Engagement	PST Characteristics St. Characteristics St. Understanding	Lesson Structure PST Characteristics St. Characteristics St. Understanding
Not Noticed		Lesson Structure	

YVETTE

Yvette's profile.

Walking into Yvette's room there are colorful posters on the wall and bulletin boards with images of food chains, bacteria, and other biological organism. There are also aquariums teaming with life. It is a highly organized classroom with neatly arranged folders, the agenda for her classes neatly posted, and six clean labs tables in the back of the room.

Yvette is the department chair at the study site and at the start of the study she had been teaching science at the school for 12 years. In college she majored in Psychology but later decided to go into teaching. She has certification to teach Biology, Psychology, and Health. She is in her mid-30's and the mother of two young children. During the study she was teaching Biology, AP Biology, and in her first year teaching Aquatic Science. She began an online Masters degree in Educational Administration in the middle of the study. Yvette is an organized and systematic teacher who regularly looks at test data to make instructional decisions. She has a strong relationship with her students and she often plays music in her room before school when students are there for help or just to talk with her. She is also a science club sponsor and throughout the year she organizes field trips and guest speakers for the members.

Yvette reports being comfortable with the messiness of student inquiry in her class. She describes that having students work in groups and talking to each other to share ideas as a critical element in her teaching. As a science teacher her goals are to teach her

students to think critically and help them see the scientific method as a way of thinking that they engage in during their everyday lives. Another of her goals if to help students make connections between classroom science and the real world so that they will come to see the big picture and come to understand why we care about science. She reports that asking students "why we care" about specific science concepts is an element of all her curricular units.

For Yvette, the ideal science lesson is one that is somewhat unstructured but that generally follows the 5E model. In her description this lesson starts off with something that is truly engaging. Yvette describes engagement for her students as something "to get them thinking, to get them questioning things, to get them excited about what is going to come next" (Yvette, Pre Interview, Nov. 2011). In her "ideal lesson" Yvette would then move on to having her students explore the science concept to "let them see if they can figure it out on their own, let them see if they can find a pattern instead of just giving them the answer" (Yvette, Pre Interview, Nov. 2011). She next describes how she would check in with the students to find out what ideas they have formed and clear up misconceptions. She sees her role as that of a facilitator; someone who clarifies and elaborates on student ideas because she says, "It's more meaningful if they build their own connections." (Yvette, Pre Interview, Nov. 2011)

Yvette is experienced in working with pre-service teachers. At the start of this study she had been working with the teacher preparation program in this study for seven years and had also hosted pre-service teachers for other universities. She described her role as a cooperating teacher in similar terms to her role as a science teacher. In

discussing her interactions with her pre-service teachers she says, “I like to have them pose questions instead of giving them the answer. Let them see if they can come up with something. And, modeling reflective practices. I see that as my main goal” (Yvette, Pre Interview, Nov. 2011). She described wanting to give the pre-service teachers the chance to try things out while providing them with advice and tools to help them in the classroom.

Yvette’s characteristics as an observer.

Yvette was actively engaged in watching the class and giving feedback. On average she spent 92% of her time in the classroom observing the lesson and writing down feedback. During the time she was not engaged she was typically distracted by other teaching tasks such as taking attendance, responding to someone at the door, or organizing the classroom.

During the study Yvette often observed from the perspective of a student. During whole class portions of the lesson she sat in a student desk and asked for copies of any materials that the students were given. She did not circulate during group work but instead she integrated with a single student group as they went through the lesson. Acting as a student she often tried to work through the lesson with them. She periodically moved to other groups but she stayed with individual groups for long periods. Due to the nature of her observations she did not visit with more than one or two groups. During the lesson she regularly checked on the well being of her students asking questions like, “Are you ok? Do you understand?” and, “Do you need help?” Yvette also rarely intervened in the

lesson.

In terms of the written artifacts, Yvette toggled back and forth between the observation form and the noticing form. She also used the pre-service teachers' lesson plan as a reference throughout her observation. Yvette often started an observation by filling out the basic information on the feedback form (date, period, etc.). She wrote evenly on the feedback form and the noticing form throughout the lesson. Near the end of the lesson she often took time to review her feedback and add comments. During the lesson debrief Yvette regularly began by asking the pre-service teacher about his or her thoughts. Her feedback was then given in response to the things that they brought up. Her comments typically started with the positive element and then led into more critical feedback along with suggestions for improvement. Yvette used her feedback form to guide the discussion.

During the period of the study Yvette hosted two different science teams, each teaching three 90 minutes lessons. The team for fall 2011 was made up of three students. The team of pre-service teachers in spring 2012 consisted of two students; however, one of the students dropped out and was not present for the last teaching event. The following section of this case will describe Yvette's noticing by lesson event as well as her noticing trends.

Yvette's noticing by lesson event.

Lesson event one.

Yvette's lesson event one was a two-day lesson occurring on November 14 and 16, 2011. The lesson was taught to a Pre-AP Biology class and topics covered over the two days were DNA structure and DNA replication. The lesson was taught by a group of three pre-service teachers. During the first day of the lesson the students were given a paper DNA model that they were asked to cut out and put together individually. The students were then asked to put their individual models together to create one class model. The pre-service teachers described the patterns found in the model to the students. The lesson ended with a lecture about the structure of DNA. On the second day of the lesson the students were placed in groups and provided with a model to use in simulating the steps of DNA replication. There was then a class debrief about the modeling followed by a lecture on the process of DNA replication. The lesson ended with a post assessment.

During lesson event one, general pedagogy and student understanding were areas of primary focus for Yvette comprising 28% and 22% of her noticing instances respectively. Areas of secondary focus for her noticing were the science content being presented (18%) and students' engagement (15%). The remaining noticing topics each received less than 10% of Yvette's attention. It should be noted that Yvette had no noticing instances in the area of pre-service teacher characteristics for lesson event one. Figure 4.5 shows Yvette's noticing for lesson event one.

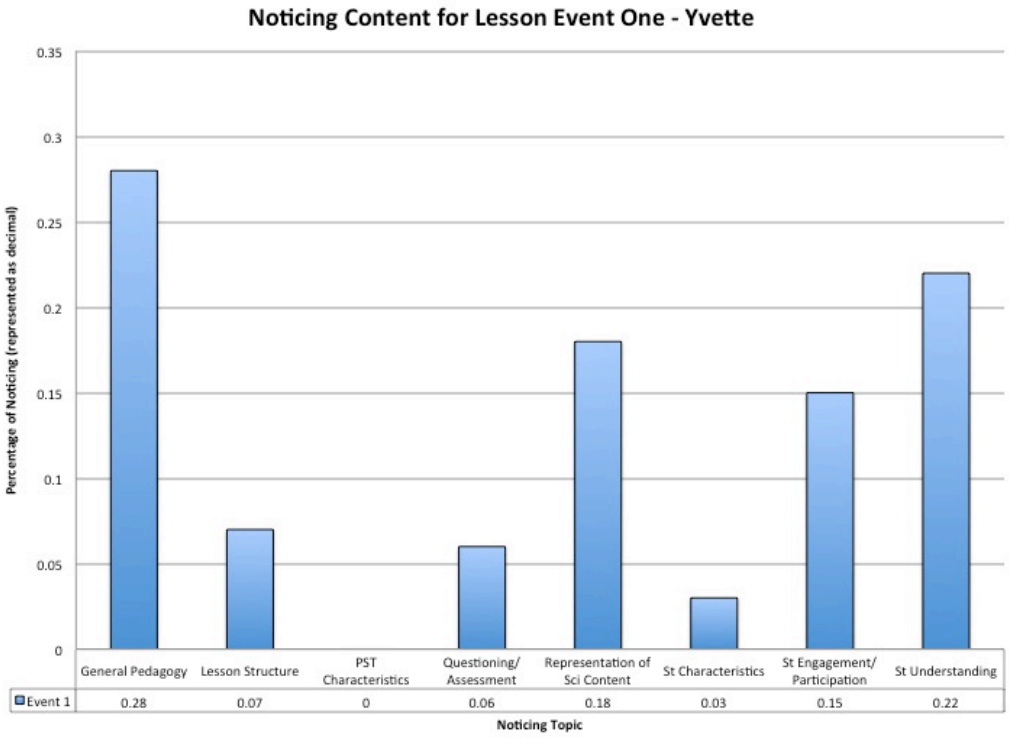


Figure 4.5. Yvette's noticing content for lesson event one

Yvette's noticing instances about general pedagogy often focused on providing clear instructions to the students. One example of this comes from a comment made to her pre-service teachers about the strategies used to give directions during the lesson. During the lesson debrief she said, "With most of the activities you had to disperse and repeat yourselves over and over. You have to create a lesson where the students can figure it out without you – give them directions that are clear." (Yvette, Lesson Debrief 1, Nov. 2011). She echoed this noticing during her post interview.

In describing what she noticed about the lesson she said. "The second part of the lesson was not explained very clearly. I think the kids struggled. They didn't know

exactly what she meant. One kid was doing it one way and one kid was doing it another way" (Yvette, Post Interview, Nov. 2011). Yvette's noticing instances about pedagogy also included the way that the pre-service teachers attempted to get the attention of the whole class. In the lesson debrief she commented to the pre-service teachers, "The hand signaling really started to work – better than Monday. Don't be afraid to try - don't give up" (Yvette, Lesson Debrief 2, Nov. 2011). Other pedagogical characteristics mentioned by Yvette were distribution of materials, modeling instructions, circulation through the room, and timing.

Another primary focus for Yvette during lesson event one was student understanding of the material being presented. She often sat with lab groups or circulated through the room to observe her students at work. In talking about the lesson she said,

> One thing that I noticed was how easily misconceptions stick with my kids. Because, on Day 1, when the kids said that when DNA unzips, it's cancer, it wasn't addressed. Then when (the pre-service teachers) showed DNA unzipping on the video, one of the students turned to me and was, 'That's cancer.' I don't think it ever really stuck with me on how misconceptions can really imbed themselves (Yvette, Post Interview, Nov. 2011).

Another example of her attention to student understanding comes from the lesson debrief for day 1. In talking to the pre-service teachers she said,

> Ezra was saying some amazing comments to you. (The students) were saying (DNA replication) is like a magnet and I was doing a happy dance inside because I was thinking hydrogen bonding and they didn't even know how correct their

thinking was. It was right on." (Yvette, Lesson Debrief 2, Nov. 2011).

Yvette's sample comments reveal attention to student understanding both in terms of the ideas they are correctly making sense of and those they are struggling with.

Yvette's noticing instances about the science content were most commonly expressed in terms of analysis of the models used during the lesson. While she did notice some positive elements of the DNA model used, she also expressed some reservations about the model and how it was being presented. In the lesson debrief for day 1 she communicated what she noticed saying,

> "You don't need as many nucleotides as you gave them in the model. I would also give them a strategy for how to break the DNA apart. In transcription and translation it is going to be read in triplets. I would add in some information about Chargaff's rule and see if they can figure out the pattern" (Yvette, Lesson Debrief 1, Nov. 2011).

She also paid attention to the way the model was used to represent the process of DNA replication during Day 2 of the lesson. During her post interview she said, "I was concerned about the structure of the DNA (model) they used because their model had the bases pairing and then the backbone just coming on" (Yvette, Post Interview, Nov. 2011). This noticing about the content led Yvette to talk about the concerns about the misconceptions of her students described in the paragraph above. Other noticing instances in this area described attention to the DNA video and the ways in which the pre-service teachers explained concepts, such as Chargaff's Rule and semi-conservative replication to the students.

Student engagement was another secondary focus for Yvette. For example, during the first lesson debrief she noted, "I saw Amelia and Erin were doing a really good job. They were learning from each other and trying to figure out how to put the model together even though I don't think Katie ever actually put hers together" (Yvette, Lesson Debrief 1, Nov. 2011). Another example comes from the second lesson debrief. During the debrief she commented, "I wasn't sure everyone way listening to the answers [from the other students] so how can we make them a part of it? How can we get more people thinking about it than just the people on the popsicle stick?"(Yvette, Lesson Debrief 2, Nov. 2011). In each of these cases Yvette's comments reveal attention to the engagement of her students with the lesson.

Lesson event two.

Lesson event two was a one-day lesson taught to an Aquatic Science Class. The lesson was taught by a pair of pre-service teachers and was about coral reefs. At the start, the students were paired and ask to develop a list of reasons for the importance of coral reefs. Student were then shown a video about coral reefs and given questions to answer. After sharing their observations from the video, students were given a challenge question about what they would do, as a government, to protect coral reefs. In the final activity, the student used a computer simulation to explore coral reefs.

For lesson event two, Yvette's noticing indicates that her primary focus was on general pedagogy and student engagement. Each of these topics account for 22% of Yvette's noticing instances. The presentation of the content received slightly less

attention with 18% of her noticing falling under this topic. The other five noticing topics received limited focus with less than 10% of Yvette's noticing falling into each of the categories. Figure 4.6 displays these findings.

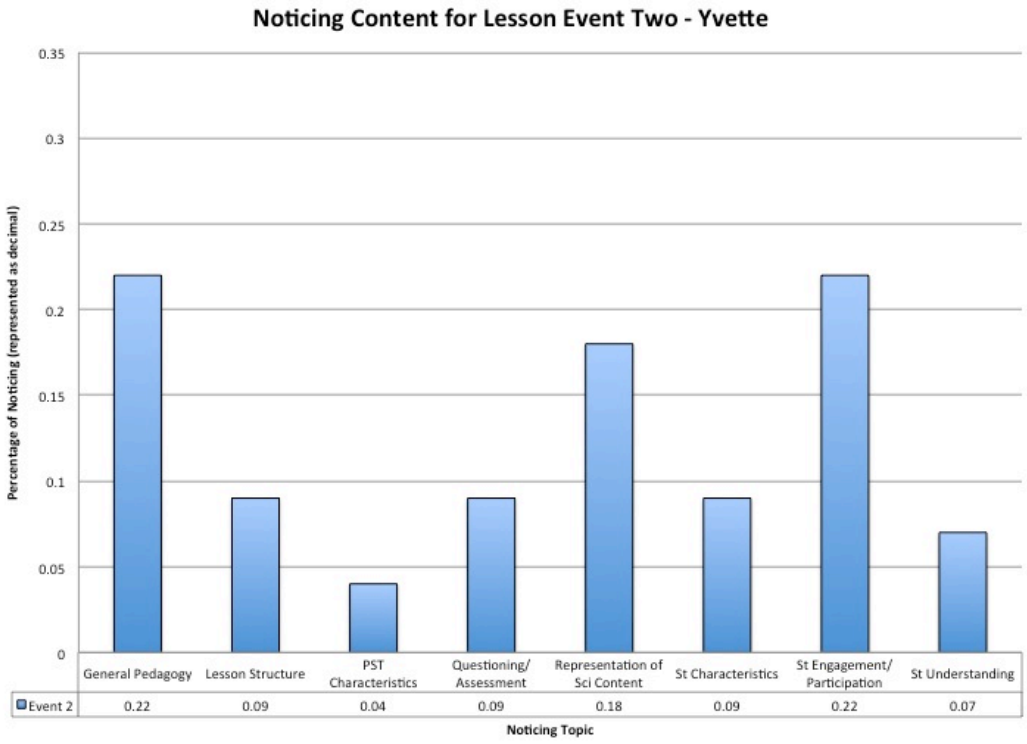


Figure 4.6. Yvette's noticing content for lesson event two

During lesson event two, Yvette attended to several pedagogical elements. One element that she noticed several times was the strategy used by the pre-service teachers to call on students. During the lesson debrief she suggested that the pre-service teacher "work on calling them by their name, and maybe knowing where they sit. Spending a little time with having the seating chart out, that might help you" (Yvette, Lesson

Debrief, Feb. 2012). She also mentioned this during her post interview. In talking about what stood out to her she said, "They started using popsicle sticks to call on students. I think [the pre-service teacher] picked up on the need for a strategy for calling on kids. She got me and asked for my popsicle sticks, and that was good" (Yvette, Post Interview, Feb. 2012).

As in lesson event one, Yvette attends to the clarity of the instructions provided by the pre-service teachers. Her comments describing the lesson demonstrate this focus. She said, "I felt like the directions were vague. I don't think [the pre-service teachers] had a clear idea of what the students were supposed to get out of the day" (Yvette, Post Interview, Feb. 2012). Other pedagogical elements noticed by Yvette included strategies for grouping, modeling for students, and transitions between lesson activities.

Student engagement and participation was another focus for Yvette. In her post interview, Yvette described the start of the lesson saying, "The [pre-service teachers] just said, 'What do you think about coral?' There was no introduction at all. I think a lot of my kids were not engaged because they didn't even know who they were" (Yvette, Post Interview, Feb. 2012). She continued to mention student participation as something she noticed as the lesson went on. In discussing what she saw she described the actions of individual student in her class saying,

> Xavier, was engaged. He liked the computer program. He had some suggestions for how to improve it but I think he was too shy to say something. Anisa is hard to crack. She withdrew during the lesson, with guest teachers. I don't think she participated in anything at all during the lesson. Samuel was highly engaged and

asking some really good questions for the group" (Yvette, Post Interview, Feb. 2012).

This comment shows that in addition to student participation in general, Yvette was noticing the engagement of particular students. Quotes like these illustrate Yvette's attention to student participation and engagement throughout the lesson event.

The ways that pre-service teachers presented the science content of coral reef ecosystems also received a significant amount of Yvette's attention. Her noticing instances in this area centered primarily on the computer simulation being used by her students to explore the concepts. The post interview provided multiple instances of her noticing in this area. For example, in one comment she said, " I found the computer program interesting. I thought it had the potential to be fantastic" (Yvette, Post Interview, Feb. 2012).

She elaborated on this comment later in the interview saying, "There were a lot of things [in the simulation] that the kids could manipulate in the ecosystem, change, get variations. The graph was complex so they actually had to think about what it was showing them" (Yvette, Post Interview, Feb. 2012). Evidence of her attention to the simulation was also present in the lesson debrief. In discussing her thoughts on the lesson with her pre-service teachers she said,

> I was thinking that a good way of doing the ecosystem simulation would be having scenario cards for each group. Have them change one variable, do it multiple times, draw this, what's your prediction? And going through the

scientific method with each scenario, changing one thing, multiple trials, writing predictions" (Yvette, Lesson Debrief, Feb. 2012).

Other noticing instances in this topic included attention to the information presented in the coral reef video.

Lesson event three.

Event three was a two-day teaching event that took place on April 5th and April 10th, 2012 in an Aquatic Science Classroom. An individual pre-service teacher taught the lesson and the concepts covered over the two days included energy transfer, carrying capacity, and mortality rates in tropical ecosystems. The lesson for day one started by having the students work in groups to place pictures of various organisms into locations on a world map where they thought the organism lived. This was followed by a short class debrief. Finally, students used a computer simulation to explore ecosystem dynamics. The lesson ended with a short assessment. Day two began with students participating in an activity simulating the exponential spread of a virus within an ecosystem. The rest of the lesson involved another computer simulation, which was designed to have the students explore mortality rates and carrying capacity within an ecosystem.

The primary focus of Yvette's attention during lesson event three was on the science content being presented. This area accounted for 27% of her total noticing instances for this event. Areas of secondary focus included lesson structure, general

pedagogy, and student engagement. Yvette's remaining noticing instances were divided into the topics of questioning and assessment, student characteristics, pre-service teacher characteristics, and student understanding, each receiving limited focus. Figure 4.7 shows the content of Yvette's noticing for this event.

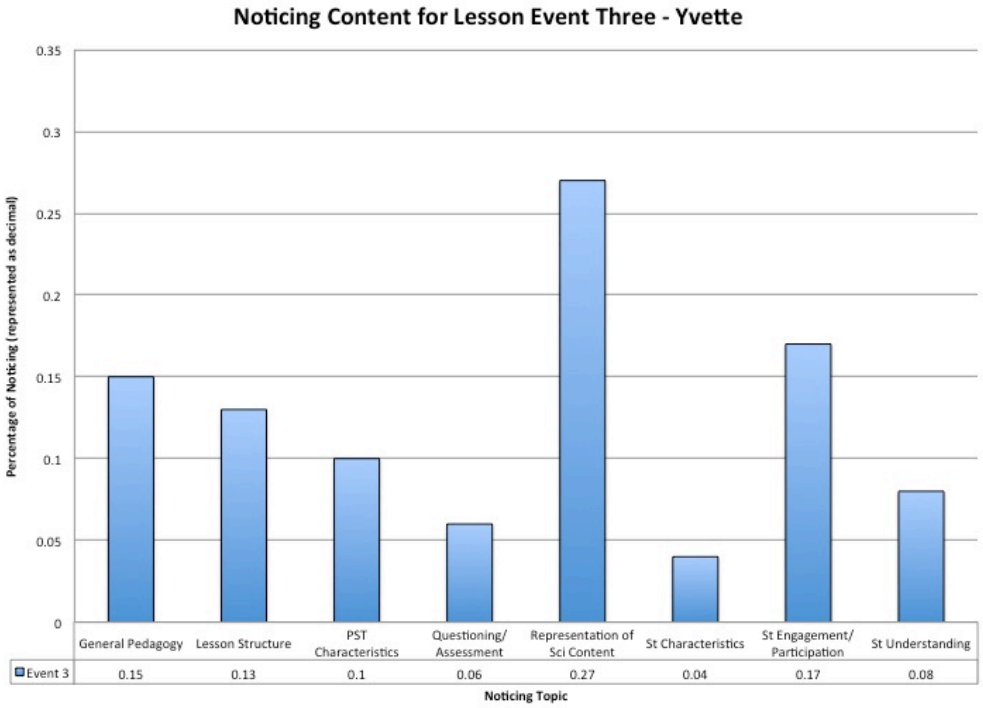


Figure 4.7. Yvette's noticing content for lesson event three

Though the lesson was presented to an Aquatic Science class, the pre-service teacher did not discuss aquatic ecosystems but instead focused on the ecosystem concepts in broad terms and used terrestrial examples throughout both lessons. In noticing the science content, this disconnect was an area of repeated attention and concern for Yvette.

In her interview, Yvette reported this as her main noticing from the lesson. In describing the lesson she said, "The biggest thing was that none of her lessons had to do with Aquatic Science" (Yvette, Post Interview, Apr. 2012).

She communicated her attention to this area with the pre-service teacher during the lesson debrief saying, "It's an Aquatic Science class, but you were teaching really an Environmental Science lesson. And, the kids don't care that the concepts are universal" (Yvette, Lesson Debrief 1, Apr. 2012). The focus on the content of the lesson was repeated throughout the conversation. For example, Yvette went on to say, "I think your warm-up could have been the same thing. But instead of having the tundra or all of those ecosystems, put in all the aquatic environments" (Yvette, Lesson Debrief 1, Apr. 2012). Comments of this type are found throughout the lesson debrief as well as the interview and account for 10 of Yvette's 14 noticing instances in the category. The other four instances in this category discuss the content presented during the computer simulation and during the virus activity.

A disconnect between the content of the course and the science content presented in the lesson seemed to be influential in her noticing of lesson structure during event three. Many of her noticing instances in this area focused on the use of objectives and state standards when designing a lesson. For example, in discussing the design of the lesson she said, "I think there were twelve (state standards) that you put on (the lesson plan). It would be better if you would focus. Which ones are you really trying to hit in your lesson?" (Yvette, Post Interview, Apr. 2012).

Her attention to this element was reiterated in her interview for event three. As

she talked about her noticing instances she said, "The objectives (in the lesson plan) weren't objectives, they were just statements. The objectives should guide the lesson but I don't think (the pre-service teachers) know what that means" (Yvette, Post Interview, Apr. 2012). She continued on this topic saying,

> The (state standards) tell us quite a bit about what the kids are supposed to be doing. But, it just seemed like (the pre-service teacher) wrote the lesson activity to activity. She had activities in her mind, then she went back to try to find a (state standard), and there wasn't one but she went ahead" (Yvette, Post Interview, Apr. 2012).

These comments are indicative of the multiple noticing instances in which Yvette attended to the use of objectives in lesson design for event three. Yvette's noticing within this topic also included attention to the planning and forethought evident in the lesson she observed.

In terms of general pedagogy, Yvette's most common noticing again focused on the type of instructions given to her students. Attention to instructions was recurring through the post interview and the lesson debrief. During the post interview Yvette said, "The lack of clear instructions was another big theme I noticed" (Yvette, Post Interview, Apr. 2012). She communicated her specific noticing in this area during the lesson debrief. In debriefing the lesson with the pre-service teacher she said,

> I would say if you had to focus on something it would be your instructions. And not that you're not clear when you say them, but for a lot of the instructions you were giving today there were too many steps involved. And after the second step,

third step, the kids were forgetting what you said was the first step. I always like to write out my instructions, and also say them verbally" (Yvette, Lesson Debrief 1, Apr. 2012).

She continued in this line when discussing the computer simulation the pre-service teacher used. She said, "The first direction was 'Familiarize yourself with the simulation.' What does that mean? What is it you actually want them to be able to do with that part?" (Yvette, Lesson Debrief 1, Apr. 2012). Other noticing instances in the area of general pedagogy for event three included circulation through the room and grouping strategies.

Student engagement was another area of attention for Yvette. She attended to the overall levels of participation as well as noticed the engagement level of specific students in her class. In discussing one of the first lesson activities she observed, she pointed out to the pre-service teacher that, "I didn't think the first activity would work at all. No way that they're all going to be working together trying to put their cards up there. And they did it. So they surprised me" (Yvette, Lesson Debrief 1, Apr. 2012). In another example, Yvette illustrates her attention to the engagement of a specific student during the computer simulation. In the lesson debrief she said, "It's great when you have something that holds individuals accountable. So something that would have held Cara accountable (for the activity). Instead, Beatriz did everything. I think she was working on every little thing and Cara barely helped her" (Yvette, Lesson Debrief 1, Apr. 2012).

Yvette's noticing trends

Yvette's case in unique is that she is the only teacher in the study to observe lessons in two different content areas, Biology and Aquatic Science. For Yvette, the noticing topics of general pedagogy, student participation, and the representations of the science content presented are areas that receive attention across lesson events. A picture of Yvette's noticing over the three lesson events is presented in Figure 4.8.

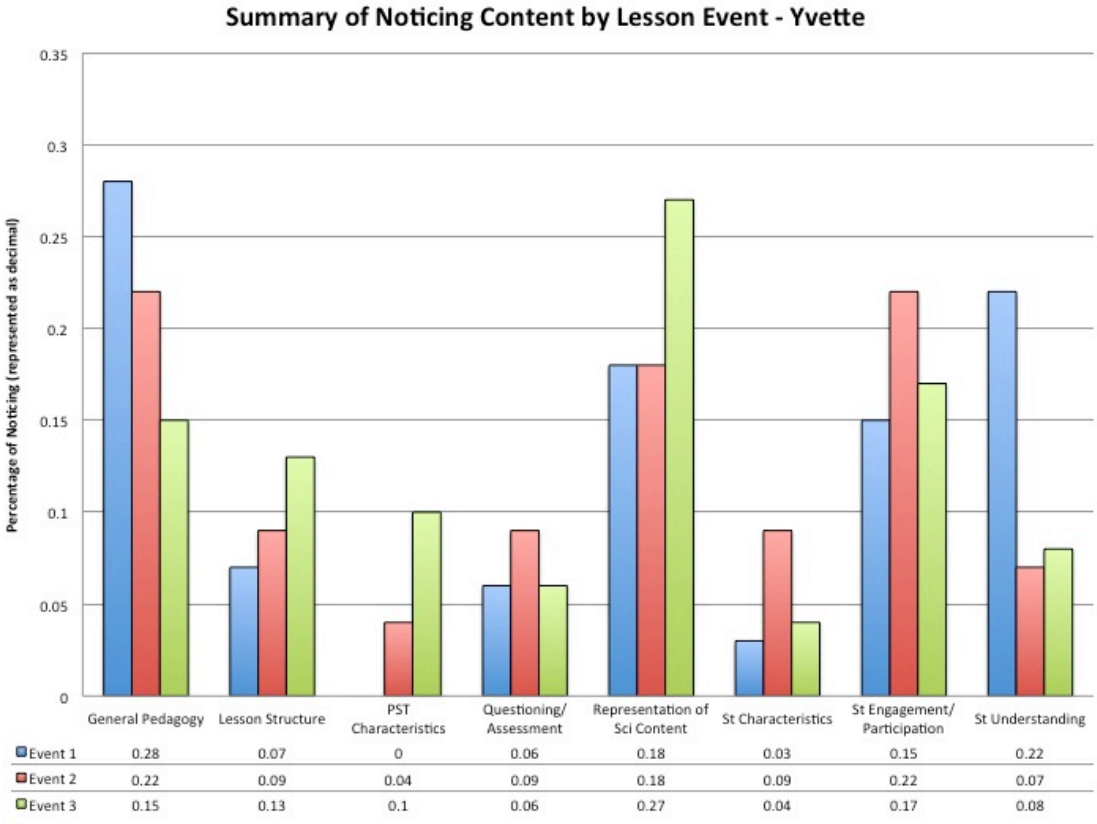


Figure 4.8. Summary of Yvette's noticing content by lesson event

In terms of general pedagogy, Yvette most frequently noticed the clarity of the

instructions given as well as whether or not the lesson objectives were made clear to the students. In terms of student participation, Yvette noticed both general levels of participation and made reference to specific observations of the engagement of particular students in her class. In attending to science content, Yvette analyzed the effectiveness of the models and simulations used to communicate the content across lessons. However, in lesson event three her focus in this area was on alignment of the science content with state standards and district objectives.

Yvette's attention to lesson structure and student understanding varied between the three lesson events. Questioning and assessment and student characteristics accounted for less than 10% of her noticing instances across lesson events. Table 4.2 shows a breakdown of Yvette's noticing by areas of focus across lesson events

Table 4.2. Yvette's noticing by areas of focus across lesson events

Focus	Lesson Event 1	Lesson Event 2	Lesson Event 3
Primary	General Pedagogy St. Understanding	General Pedagogy St. Engagement	Science Content
Secondary	Science Content St. Engagement	Science Content	General Pedagogy Lesson Structure PST Characteristics St. Engagement
Limited	Lesson Structure Question/Assessment St. Characteristics	Lesson Structure PST Characteristics Question/Assessment St. Characteristics St. Understanding	Question/Assessment St. Characteristics St. Understanding
Not Noticed	PST Characteristics		

EMALINE

Emaline's profile.

Upon entering Emaline's classroom one's eyes are immediately drawn to the size. The large room has desks arranged in rows with a perimeter of lab tables on the left hand side and back wall. There is a large concrete column in the middle of the room, an unfortunate result of a recent building remodel where this room was constructed from two smaller classrooms. While there are some posters of microscopes, atoms, and beakers around the room most of the wall space is taken up by built-in cabinets, a goggle cabinet, and a large fume hood.

Emaline is an experienced science teacher who was starting her seventh year of teaching at the time of the study. She is an athletic mother of three in her late 30's. She has a lively personality, she is enthusiastic, and her classroom has a fun and relaxed quality to it. She has developed strong personal relationships with many of her students and they will come by at lunch or after school to meet with her. Emaline has a degree in Biology and is certified to teach all secondary science courses. At the time of the study she was teaching Chemistry and Pre-AP Chemistry and was serving as the chemistry curriculum liaison between the school and the district. During the year of the study, Emaline enrolled in an online master's program and she became the new teacher mentor for the campus.

As a science teacher Emaline wants students to become interested in science, but most importantly she wants to help them become critical consumers of information. She

says, “I really want my kids to be able to question everything and figure out whether the information they are being told makes sense, has some validity” (Emaline, Pre Interview, Nov. 2011). She wants to provide them with decision-making skills that they can use in everyday life to evaluate the information they come in contact with. She wants to foster a sense of confidence in her students and she prides herself on the positive feedback she gives. She does not want her students to be intimidated by science.

She considers herself to be a flexible teacher that doesn’t have one style of teaching science. While she likes having the students do open ended inquiry she mentioned being concerned about safety in the Chemistry classroom. Her main focus is on giving students time to process information. In describing an ideal science lesson she says, “I would like to see the kids first go try it, explore it, and come back and try to organize their ideas and share out. That can happen in a bunch of different ways” (Emaline, Pre Interview, Nov. 2011).

She sees her role during these types of lessons as helping them to organize their thoughts so that they align with the high school curriculum. Since she wants student to learn to think critically in different situations, her ideal science lesson would sometimes include group work but other times students would be working on their own. She also feels that there are certain topics, like teaching students molecular formulas, where direct teaching is the best way to start the lesson. She says, “Sometimes I have to direct teach first, like if we are doing something that is really hard to have them explore, so I think I’m flexible.” (Emaline, Pre Interview, Nov. 2011).

At the start of the study, Emaline had hosted pre-service teachers for two years. In her role as a cooperating teacher in the early field experience Emaline describes herself as an observer on different levels. She says that her role is to watch the pre-service teachers and give them advice but she also says that she is watching things for herself. In her pre-interview she said, "(The pre-service teachers) are here teaching, and I'm watching what they're doing to see if it's interesting or something that I can tweak, and I do some self-reflection" (Emaline, Pre Interview, Nov. 2011). She also sees her role as someone who is a cheerleader for the new teachers. She wants to be positive in her feedback and she feels responsible for their success.

Emaline's characteristics as an observer.

Emaline is an active observer. On average she spent five minutes out of a 90-minute observation on tasks other than observing and recording feedback. During these five minutes she was seen doing things like taking attendance, getting supplies for other teachers and, talking to visitors in the hall. During a typical observation Emaline would sit at the back of the room, getting up only to perform specific tasks. When she did get up to complete a task she would often stop to check in with and support her students. Field observations show her saying things like, "David, I missed you. I am glad you are in class today" and reassuring her student, Gina, when she seemed nervous about the lesson. She chimed in from the back, "Don't worry, he is going to help you Gina." She would also periodically engage with the students in order to give them positive feedback and let them know they are on the right track. She could be heard making comments to students

like “good work” or “I like where you are going with this” as she passed by their desks. She did not actively participate in the class but would periodically intervene to redirect students if needed.

During observations Emaline toggled back and forth between the feedback form and the noticing form. Notes from the field observation reveal that for Emaline, writing on one form was frequently followed by immediate writing on the other form. Emaline relied primarily on her feedback form when debriefing with her pre-service teachers. Much of the written feedback on the form was also communicated orally to the students. In addition to critique, Emaline gave a lot of supportive feedback to the pre-service teachers.

During the period of the study Emaline hosted two different teams of pre-service teachers. In the fall of 2011 she hosted a pair of students that taught lessons on the molecular geometry of various compounds. In the spring of 2012 she had a single student teaching in her classroom. She assigned him the topic of Valence shell electron pair repulsion (VSEPR) theory. In her post -interview she mentioned assigning him this topic because it is something she always wanted to teach but wasn’t sure how she would do it or if it was worth the time it would take way from other topics. She wanted to see where the pre-service teacher would go with it in order to help her make this instructional decision. The following section of this case will describe Emaline’s noticing by lesson event as well as her noticing trends.

Emaline's noticing by lesson event.

Lesson event one.

Event one was a two-day lesson that was taught to a Pre-AP Chemistry class during November of 2011. The lesson was taught by two pre-service teachers and covered the topic of the molecular geometry of chemical compounds and VSEPR (Valence Shell Electron Pair Repulsion). The cooperating teacher was only present for the first day therefore this section focuses on her noticing from that day.

The lesson she observed started with a warm up introducing a ball and stick model of methane. Students were given whiteboards on which to respond to warm up questions. This led to a lecture over Lewis Dot Structures, valence electrons, and bonding. The students were then placed in groups and asked to create 3-D models of various chemical molecules using toothpicks and marshmallows. They were then asked to draw their models on the board.

During lesson event one, Emaline's areas of primary focus were student understanding and student engagement. These two areas made up 22% and 20% of her total noticing respectively. Topics of secondary focus included representation of science content and general pedagogy, each receiving 15% of Emaline's attention. The remaining topics each accounted for less than 10% of Emaline's noticing instances. Figure 4.9 depicts the content of Emaline's noticing for this event.

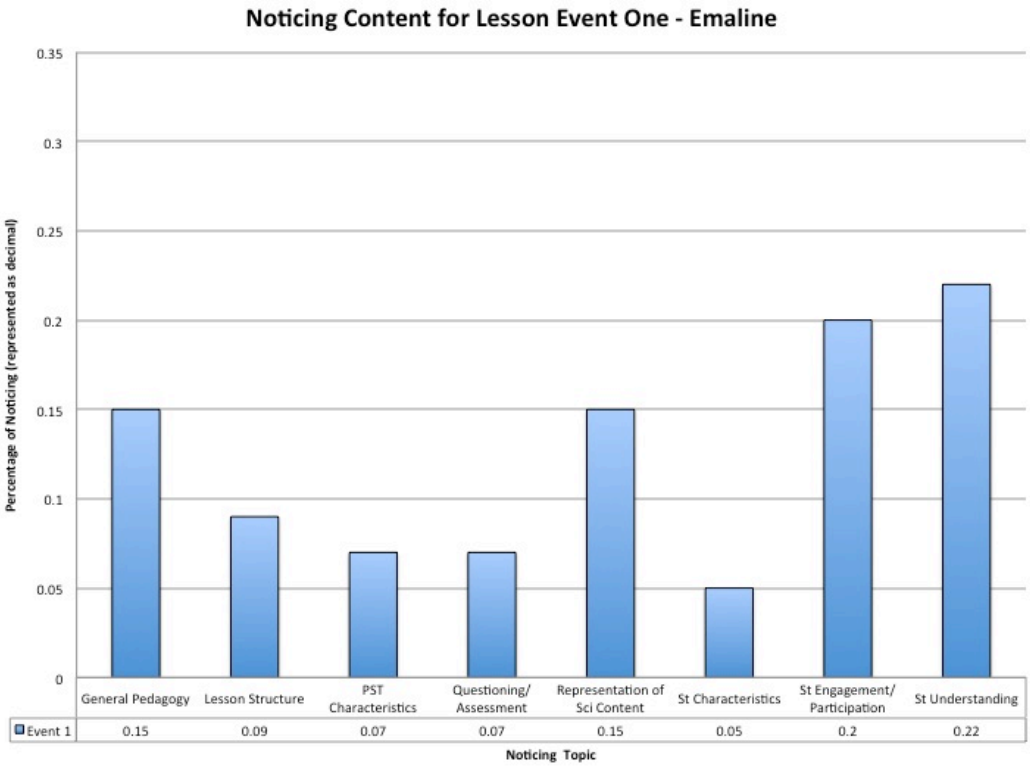


Figure 4.9. Emaline's noticing content for lesson event one

Emaline primarily attended to student understanding of the science content during lesson event one. She noticed the ways in which her students were using the models to make sense of the 3-D shapes of molecules and compounds. An example comes from her post interview in which she says, "I think that when students can come to the realization that these things are three-dimensional it's this whole new world. I was really excited to see how many light bulbs I felt went off in the room today" (Emaline, Post Interview, Nov. 2011).

In addition to noticing concepts she felt her students were grasping, she also

noticed misconceptions present during the lesson. As an example, when Emaline continued to describe the lesson she said, " I heard some very common errors today. When the [pre-service teachers] asked 'What group was such-and-such in' and everybody answered it's in Group 8. It's not really in Group 8, it's in Group 18, but it has 8 valence electrons" (Emaline, Post Interview, Nov. 2011). Comments demonstrating Emaline's attention to student understanding were commonly found in analysis of the data for event one.

Another topic of primary focus for Emaline was student engagement and participation. Analysis of the data shows that Emaline noticed the level of participation of her students on multiple occasions. For example, in describing what she noticed about the start of the lesson she said, " [The students] were talking across the room and there were a lot of comments going on back and forth. Then, all of the sudden, when they started to learn the content and they felt challenged, everything got much quieter" (Emaline, Post Interview, Nov. 2011). In this comment Emaline noticed elements of student engagement and tied them back to the content of the lesson.

She also noticed times when individual students were not participating. In discussing her observations of student during the model building activity she reported, "I wrote a note to myself, are Trey and Samantha being forgotten in the back by (the pre-service teacher)? And by me?" (Emaline, Post Interview, Nov. 2011). Comments of this kind reveal Emaline's attention to student engagement throughout the lesson.

15% of Emaline's noticing instances during event one focused on the topic of general pedagogy. Examples of comments revealing her attention in this area can be

found in both the lesson debrief and post interview. During the lesson debrief her comments included noticing that the warm up was posted at the start of the lesson, enabling the students to start working right away. She also mentioned noticing things like lesson timing and materials management. When describing her noticing instances during the post interview, she made comments like, "They didn't come out from the behind the desk for about thirty minutes" and "They did a good job taking up the white boards. Obviously last time they realized that having the white boards out the whole lesson was causing kids to be off track" (Emaline, Post Interview, Nov. 2011).

Representation of science content accounted for another 15% of Emaline's total noticing instances during event one. She paid particular attention to the use of the 3-D models the pre-service teachers used to teach the lesson. During the post interview she described her thoughts about the models saying,

> (The pre-service teacher) held up the stick model (of methane) and she said, 'What do you think this is?' Nobody had an answer and then she moved on. I thought there had to have been a way to present this differently, like giving them multiple-choice answers, or even telling them, this is CH_4, where do you think the carbon is? (Emaline, Post Interview, Nov. 2011).

She made several other references to the use of the models when discussing her impressions of the lesson. For example, she went on to say,

> The models today were actually a really good introduction to VSEPR. As long as (the students) are thinking as much as they were thinking today and having to go back to their prior knowledge on bonding, to pull it forward, to use and apply it in

some way then it is great (Emaline, Post Interview, Nov. 2011).

The quotes illustrate Emaline's attention to the science content being presented in the classroom.

Lesson event two.

Lesson event two was a one day lesson taught in February of 2012. It was taught to a by a single pre-service teacher to a Chemistry class. As in lesson event one, the topic for this lesson was molecular geometry and VSEPR, however, it was taught to a different group of students from those involved in lesson event one. The lesson started with students answering warm up questions and using whiteboards to diagram the Lewis Dot Structures of various elements. As a class the students then participated in a class activity where half of the class was asked to model attraction and the other half to model repulsion.

The students not involved in the modeling were asked to make observations about the space. The students were then split into groups and asked to build models of molecules leaving as much space as possible between the atoms. The groups then presented their results as the pre-service teacher facilitated a discussion. The lesson ended with a short lecture.

Noticing for event two shows a shift in primary focus from noticing focused on students, such as student participation and understanding, to an increased focus on elements of the lesson. Noticing instances in the areas of science content and general pedagogy each comprised more than 20% of Emaline's noticing for lesson event two.

Student participation and student understanding remain areas of secondary focus receiving 17% and 15% of Emaline's attention respectively. The remaining noticing topics were areas of limited focus for Emaline during this lesson event. Figure 4.10 displays these findings.

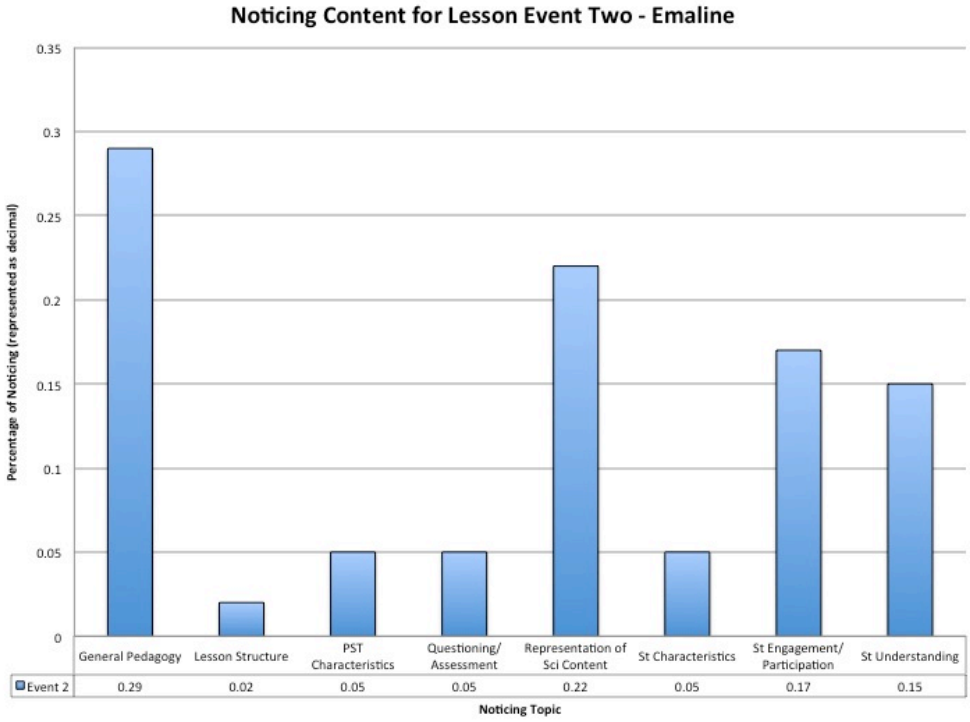


Figure 4.10. Emaline's noticing content for lesson event two

General pedagogy was an area of primary focus for Emaline during event two. She noticed pedagogical elements such as grouping, circulation, timing, systems for calling on students, and clear communication. She remarked on these pedagogical elements throughout the lesson debrief and also in the post interview. In providing

feedback for her pre-service teacher she made comments like, "You had good movement through room you didn't stand by the desk you were out here with them." (Emaline, Lesson Debrief, Feb. 2012) and "Get a system for calling on students. I use popsicle sticks because I noticed that I tend to call on the same kids. There was a name issue today and it kept recurring" (Emaline, Lesson Debrief, Feb. 2012). As the discussion went on, her comments reveal her continued attention to this area. In another example, Emaline notices that information was not being clearly communicated to the students. She suggested, "Could you label pieces of the model – or could you have explained as a group these are hydrogen, these are oxygen? I noticed you had to go to each group (to explain)" (Emaline, Lesson Debrief, Feb. 2012).

Emaline's noticing also reveals primary focus on the science content being presented. As in event one, comments show Emaline noticing and analyzing the models used in the lesson as well as the language used to communicate important concepts. For example, during the lesson debrief a question reveals her attention to the models. She asks, "Do you think the stick on the bottom of the sphere might have led to some incorrect models? I was noticing that nobody was able to place bonds on that side of the atom" (Emaline, Lesson Debrief, Feb. 2012). As she continued talking she mentioned something else she had noticed about the content. She said, "Be careful when you talk about electrons, I do this too. You meant the valence electrons but you just said electrons and it wasn't clear if you meant total or valence" (Emaline, Lesson Debrief, Feb. 2012).

Emaline also noticed student understanding and how her students were using the models to make sense of the VSEPR concept. During the post interview she

communicated something she had noticed about her students' thinking. She said, "There was one group that messed up that second model but they had a thought process as to how they got there, and I just kept thinking to myself, they're thinking, it's good" (Emaline, Post Interview, Feb. 2012). In continuing to talk about the models in terms of her students thinking she went on to say,

> Watching [the students] today, there was cooperative learning going on, they were talking to each other about where the spheres were going to go. It took thought and some that they initially thought were wrong weren't. When [the pre-service teacher] spun the models, and they were looking at them from the different orientation, and all of the sudden the kids were like, 'Oh, they do look like the rest of them' (Emaline, Post Interview, Feb. 2012).

These quotes illustrate Emaline's attention to student understanding throughout the modeling activity. She attended to student ideas during other parts of the lesson as well. For example, in describing the warm up she said,

> There was a question about hydrogen, and one of the students was like, 'That's ionic.' Ninety percent of the class was like, 'Yeah! That's ionic.' So many times I've said hydrogen is hanging out with the metals, but it's not a metal. And none of [the students] were processing that (Emaline, Post Interview, Feb. 2012).

As in lesson event one, Emaline focused on the levels of student participation during the lesson, though this topic was a secondary focus during event two. During the lesson debrief and interviews Emaline described noticing which of her students were actively participating in the lesson. For example, in talking to the pre-service teacher

after the lesson she said, “I was trying to count, when you were doing the warm up, how many groups are on track and how many were having educational conversations. I would say you had about a 50/50 split” (Emaline, Lesson Debrief, Feb. 2012). Other comments show her noticing individual students that were and were not participating during various parts of the lesson.

Lesson event three.

The two lessons that were part of lesson event three took place in April of 2012. The lessons were taught by the same pre-service teacher and in the same class as event two. The topic for the lesson was a continuation of concepts dealing with molecular geometry and VSEPR. The cooperating teacher was present only for day two of this two-day lesson. Therefore the description and noticing for this lesson event focus only on the day two lesson.

The second day of the lesson started with a warm up reviewing the concepts from the day one lesson. The pre-service teacher then asked the students to work together to create a table organizing characteristics about the various geometries (linear, trigonal planar, tetrahedral, etc.). When complete, the students shared their information with the class. Students then used styrofoam balls to build models of the molecular geometries that included "lone pairs.” Students were called up to present their models while the audience analyzed the models. The lesson ended with a lecture and assessment.

As in lesson event two, the primary focus of Emaline’s noticing was on general pedagogy and representation of the science content being presented. She also maintained

a secondary focus on student engagement and participation. However, unlike in event one and 2, student understanding was an area of limited focus. Other areas of limited focus included questioning and assessment, lesson structure, student characteristics, and pre-service teacher characteristics. Figure 4.11 shows the content of Emaline's noticing during this event.

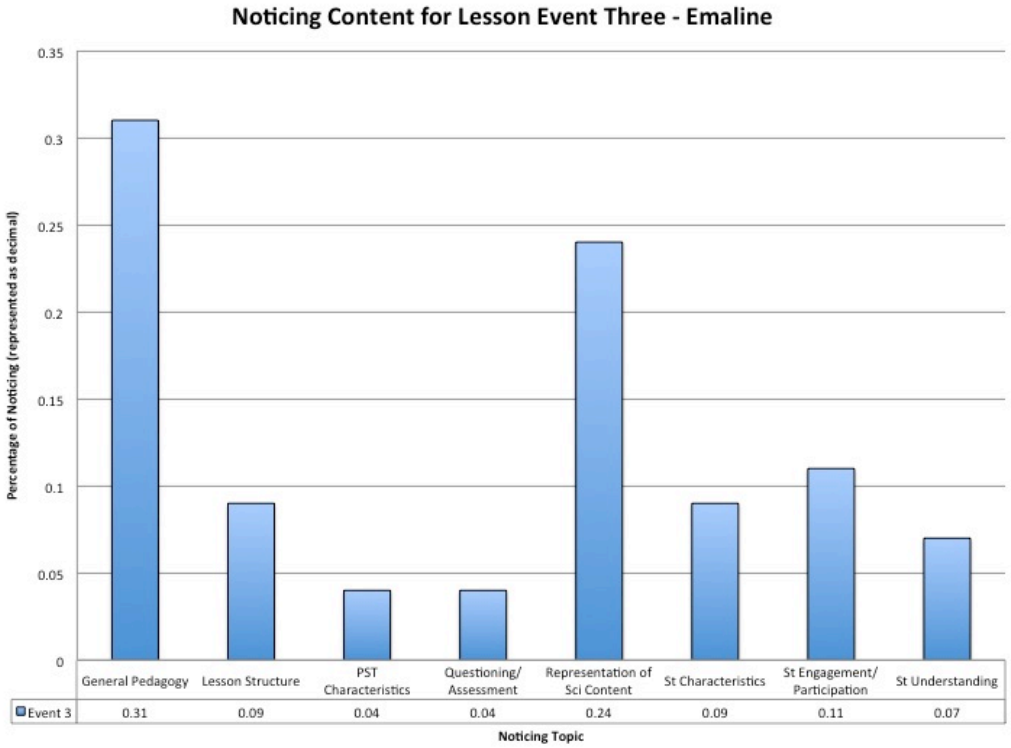


Figure 4.11. Emaline's noticing content for lesson event three

One area of primary focus for Emaline during this lesson event was representation of science content. For example, at one point in the lesson Emaline noticed the ways in which a student-created table was used to help students represent the periodic trends. In

describing the lesson during the post interview she said, "[The pre-service teacher] went into having them build a table including the number of lone pairs, the number of bonded pairs … so for me that organization was a high point and interesting" (Emaline, Post Interview, Apr. 2012). As in her previous lesson events, Emaline continued to pay attention to the way the pre-service teacher used 3D models to communicate the science content. During her post interview she recounted,

> Then [the students] came up and shared their models and talked about the similarities and differences and they continued filling in angles. I would have liked [the pre-service teacher] to really stop and clarify that the amount of lone pairs that are sitting on top of or on the molecule at some point are going to cause those angles to go up or down (Emaline, Post Interview, Apr. 2012).

This quote illustrates Emaline noticing the way the models were used during the lesson and making a suggestion for improvement. In a final example, Emaline describes her attention to the way the content of VSEPR was presented to her students saying,

> Watching these lessons on VSEPR, just realizing that there are so many different levels that you can teach it on. I don't have to go all the way to bond angles; I don't have to go into how they act with each other necessarily. For some reason in my head I had it built up that it would be like going into organic. But watching [the students] yesterday, I thought, maybe you start teaching it around water, because we teach them molecular geometry of water anyway. Why not stop for a second and just teach them molecular geometry? So it kind of helped me think about teaching it" (Emaline, Post Interview, Apr. 2012).

This quote illustrates Emaline's attention to the content as well as the impact of her noticing on her thinking about the subject.

Emaline's continued focus on general pedagogy is evident from analysis of her data for this event. In describing her noticing during the post interview she made multiple references to the pedagogical strategies of the pre-service teacher. At the start of the interview she said, "I was wondering if he could have welcomed them into class. There was, 'Hey guys, I'm glad to see you, come in' or something along those lines" (Emaline, Post Interview, Apr. 2012). She also mentioned his used of the timer during the lesson saying, "He would give the students a time frame, but no visual timer, which I thought was interesting. He was using the timer but at the same time if the kids can't see it, they can't gauge, so there's still that issue" (Emaline, Post Interview, Apr. 2012).

In addition, she attended to the ways in which the pre-service teacher circulated through the room commenting, "I saw that during warm-up my kids were extremely off-task. And I think [the pre-service teacher] was doing his best to walk around and facilitate them getting into the warm-up" (Emaline, Post Interview, Apr. 2012). This quote shows a noticing instance focused on student participation tied to a noticing about pedagogy. Other noticing instances in this area describe the pre-service teacher's pacing of the lecture, grouping of students, and preparation of materials.

In this event, student participation remained an area of secondary focus. Emaline's noticing reveals attention to student engagement and participation throughout the lesson. In discussing the start of the lesson she said, "After the warm-up, the students settled in, but I had students going as far as painting their nails and the two girls that were

connected by the same headset and stuff like that" (Emaline, Post Interview, Apr. 2012). In discussing the middle portion of the lesson with the pre-service teacher, she noted, "I noticed Darion was off track but then got on track, so try and praise the kids doing the right thing" (Emaline, Lesson Debrief 2, Apr. 2012).

In an example from the end of the lesson, Emaline described her thoughts about having the students build and present the models. In debriefing with the pre-service teacher she said, "The students were more engaged once you said they were going to get out of their seats" (Emaline, Lesson Debrief 2, Apr. 2012). This sampling of quotes shows that Emaline noticed levels of student participation throughout the lesson.

Emaline's noticing trends.

Emaline's case is unique in that she is the only cooperating teacher to have all of the lesson events covering the same general content, molecular geometry and VSEPR. A picture of Emaline's noticing over the three lesson events is presented in Figure 4.12. The graph shows the percentage of total noticing within each noticing topics for lesson events 1, 2, and 3.

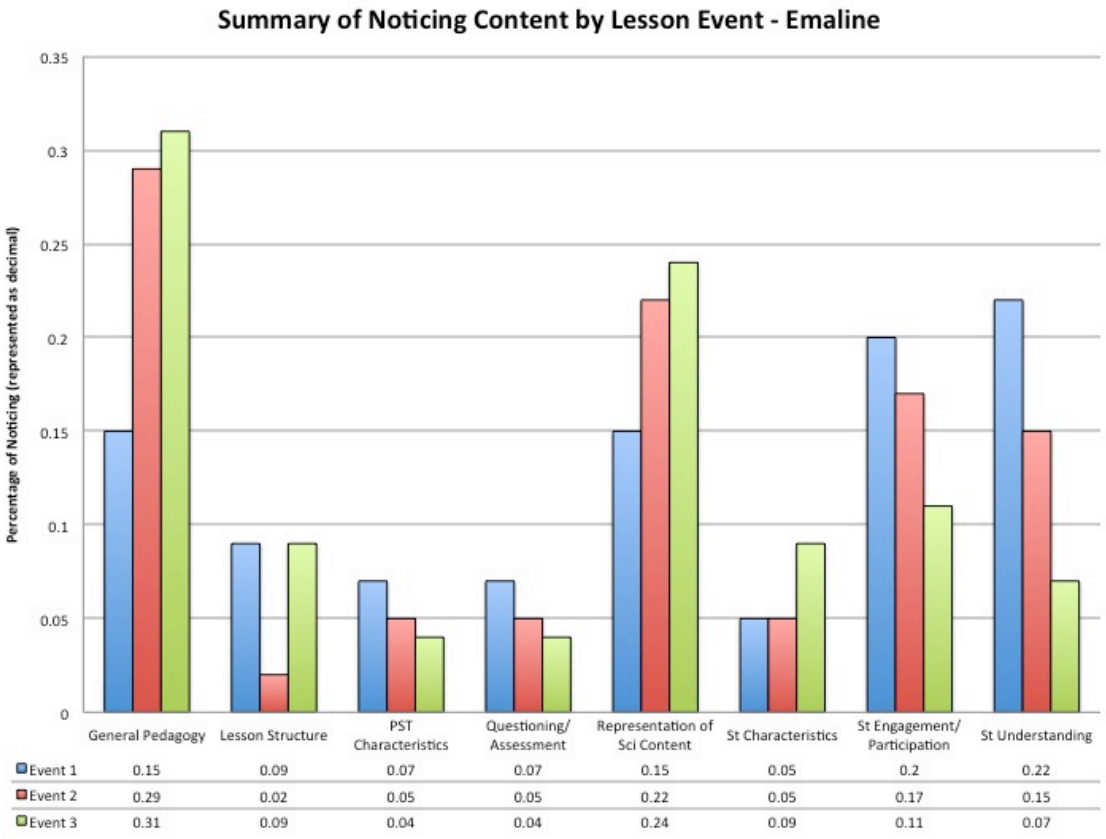


Figure 4.12. Summary of Emaline's noticing content by lesson event

Though the lesson content remained constant the representation of science content was an area of focus for Emaline in all lessons. Molecular models were used in all lesson events and Emaline's noticing often described her attention to the models and how they were used in representing the content. Other areas of consistent focus for Emaline were general pedagogy and student participation. Student understanding was an area of primary focus for event one, secondary focus for event two, and limited focus for event three. Topics of questioning and assessment, lesson structure, student characteristics, and

pre-service teacher characteristics each accounted for less than 10% of Emaline's noticing instances across events.

Table 4.3. Emaline's noticing by areas of focus across lesson events

Focus	Lesson Event 1	Lesson Event 2	Lesson Event 3
Primary	St. Engagement St. Understanding	General Pedagogy Science Content	General Pedagogy Science Content
Secondary	General Pedagogy Science Content	St. Engagement St. Understanding	St. Engagement
Limited	Lesson Structure PST Characteristics Question/Assessment St. Characteristics	Lesson Structure PST Characteristics Question/Assessment St. Characteristics	Lesson Structure PST Characteristics Question/Assessment St. Characteristics St. Understanding
Not Noticed			

NORA

Nora's Profile.

Walking into Nora's room is an inviting experience. There are bright posters around the room and student work is posted on the wall. She has the agendas for her classes posted each day and a place in the room where she recognizes a "Student of the Week". Around the room are images of periodic tables, DNA molecules, and cell division. Her room has moveable lab tables where the students sit in place of desks. The tables are arranged so that pairs of students sit facing each other creating a group of four.

Having taught for three years, Nora is the most novice science teacher of the four teachers in the study. She is a Biology major in her mid 20's and she is composite science certified. During the time of the study she was teaching Biology and was in her first year of teaching Environmental Science. She was also teaching an inclusion Biology class in which she had a high percentage of students qualifying for special education services. In this class she frequently had the support of an inclusion teacher. In her pre-interview Nora reported recently starting to feel more confident in her teaching. She had just been appointed as the Biology course group leader for her department and was considering pursuing National Board certification or working on her master's degree in the near future.

As a science teacher Nora's goal is to motivate her students. When asked about her role as a science teacher, she reported that she wanted "to get kids interested in science - especially Biology- and help them make connections to their own lives." She is

fascinated with Biology and wants to communicate that love to students through her teaching. As a teacher Nora reported striving to create a student-centered classroom where "the students are doing the intellectual work and I facilitate and ask them questions about their ideas" (Nora, Pre Interview, Nov. 2011). She also reported wanting to teach her classes through inquiry which she describes as giving students the opportunity to struggle with new ideas. She said, "This is how people learn" (Nora, Pre Interview, Nov. 2011)

Nora describes her ideal science lesson as one that is related to the real world. She does not like to stand at the front of the room and "talk at" her students. She describes the best lessons as those where "The kids are doing most of the work and I'm just facilitating, asking questions that get them to think, and they're trying to figure it out. The way you learn is by actually doing it and struggling, it's ok to struggle" (Nora, Pre Interview, Nov. 2011).

As an example of an ideal science lesson, she described an osmosis lesson she had seen modeled at a professional development that she then tried out with her students. In the lesson, the students were asked several questions about what would happen to a grape in various solutions. She said that the students "had to come up with their own experiments to test one of the questions. Then they had to get results and be able to answer the question that they wanted." (Nora, Pre Interview, Nov. 2011). She also described how helpful it was being able to refer back to this student learning experience throughout the unit on cellular transport.

In addition to being the most novice teacher in the study, Nora also had the least

experience as a mentor. At the time of the study Nora had two years of mentoring experience. As a cooperating teacher Nora sees her main role as one of support. She feels it is her job to provide the pre-service teachers with directions and suggestions that will help them as future teachers. In her interview she said, "Helpful hints is my thing" (Nora, Pre Interview, Nov. 2011). She also noted that it is especially important for her to provide support in the area of classroom management because she feels that new teachers typically are not strong in this area. She related that, in her view, a lack of effective classroom management leads to difficulties in other areas. In talking about her experience with the pre-service teachers Nora says, "A lot of times their lessons are really good but their management just messes up the whole thing." (Nora, Pre Interview, Nov. 2011)

Nora's characteristics as an observer.

Like the other teachers in the study, Nora is an active observer. She was observed to actively attend to the lesson over 90% of the time. The remainder of her time was spent taking attendance, answering student questions, and looking at student work.

During lesson observations Nora typically sat in the back of the room throughout the entire lesson. She stopped and checked on students if she was getting up to answer the door or take attendance on her computer. During lesson event two and 3 an inclusion teacher was also present. This teacher sat at the back of the room with Nora and they would whisper to each other periodically throughout the lesson. Nora reported that these conversations were focused on observations of particular students but those conversations were not captured for the study. Nora did not actively participate or intervene in the

lesson and she rarely redirected students. She interacted with students if they asked her a direct question but she often responded by directing them to ask the pre-service teacher.

Nora typically toggled back and forth between the noticing form and the feedback form. She took her time when writing her thoughts on the noticing form. She consistently recorded the time or each entry and wrote her noticing instances as complete thoughts instead of the shorthand used by other teachers. During lesson 2 and 3 she was often observed to write on the noticing form right after conversing with the inclusion teacher sitting by her. Nora used both the noticing form and the feedback form as guides during lesson debriefs.

During the period of the study Nora hosted two different pre-service teacher teams. The two teams each taught three 90-minute lessons in her classroom. The first team lessons covered the topics of DNA structure and DNA replication during fall 2011. The second team covered the topics of evolution and plant structure during spring 2012. The following section of this case will describe Nora's noticing by lesson event as well as her noticing trends.

Nora's noticing by lesson event.

Lesson event one.

Event one was a two-day lesson taught in November of 2011. A pair of pre-service teachers in a Biology class taught the lesson. The topics for the two days were DNA structure and DNA replication respectively. On day one the lesson began with a

warm up looking at the genetic code of different organisms. The students then used a worksheet and cut outs of DNA parts to assemble a DNA molecule. After the DNA was assembled the pre-service teachers led a discussion about patterns in the molecule followed by a short lecture. On day two the lesson started with a warm up reviewing nucleotide structure. The students then participated in an activity where they used their bodies to model DNA replication. In the next activity, the pre-service teachers used a large whiteboard and a magnetic model of DNA to illustrate the process of replication. The second day ended with a lecture about the semi-conservative model.

Overall, there were three areas of primary focus for Nora during event one. Over 20% of her noticing instances fell under each of three topics: general pedagogy, representation of science content, and student engagement. Nora's data shows no areas of secondary focus for this event. The remaining noticing topics each received limited focus except for the topic of pre-service teacher characteristics, which was not mentioned. Figure 4.13 shows Nora's event one noticing by noticing topic.

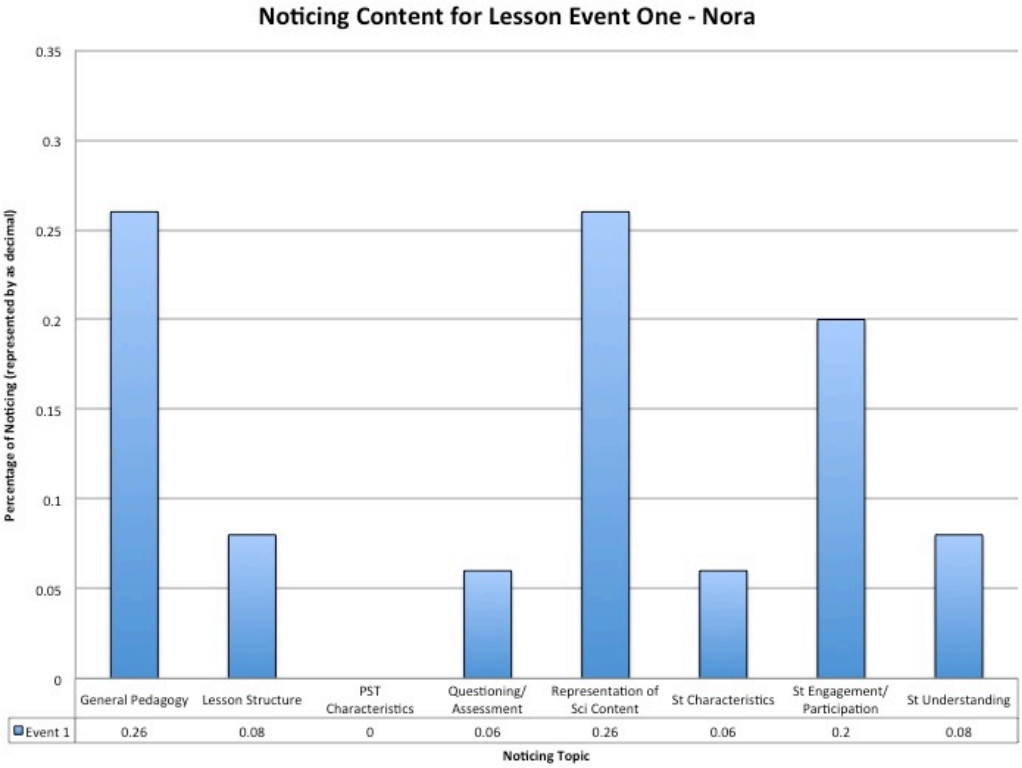


Figure 4.13. Nora's noticing content for lesson event one

The representation of the science concepts presented in the lesson was a primary focus of Nora's noticing during event one. Two elements of the lesson accounted for multiple noticing instances within the topic. One was the human DNA model that the students participated in. In describing what she noticed she referred to this modeling activity on several occasions. During the post interview she said that the pre-service teacher "had the kids [make] a human model, and the kids stand up and do DNA replication. It was really cool. I had seen the human model before but I hadn't ever done it" (Nora, Post Interview, Nov. 2011). She mentioned the activity again later in the

interview when she said, “I really liked the human DNA model; it was very kinesthetic the whole time and very student centered. It was the students helping the teachers with replication” (Nora, Post Interview, Nov. 2011).

Another representation of science content that she noticed frequently was the magnetic nucleotides used to illustrate the concept of DNA replication. Comments during her post interview reveal Nora noticing this model several times. For example, in describing the lesson she said,

> [The pre-service teachers] made their own model of nucleotides. Each nucleotide was on an index card and it was cut in a certain way, so the As fit like a puzzle piece with the Ts and Cs with Gs. Their original strand was on white index cards, and then they had free-floating nucleotides in blue. They showed the kids how it unzips, and then they pulled in the free floaters which were blue. This pointed out that it’s a semi-conservative model. I thought they were fantastic” (Nora, Post Interview, Nov. 2011).

She also mentioned her impressions of the models to the pre-service teachers during the lesson debrief. In debriefing with them she said, “When I saw the magnets I was like, ‘I want to steal those!’ I liked how the new pieces were blue and the old pieces were white, and you could tell it was semi-conservative” (Nora, Lesson Debrief 2, Nov. 2011). These comments indicate that Nora attended to various aspects of the science content and how it was represented during the lesson.

Nora also attended to general pedagogy during the lessons of event one. Her noticing in this area included attention to circulation, the posting of lesson objectives, and

strategies for getting student attention. For example, in during the first lesson debrief for this event Nora told the pre-service teachers, "You were up here writing and talking but you should walk around. You were standing up here at the front but it's the guys in the back that were [off task]" (Nora, Lesson Debrief 1, Nov. 2011). She also noticed pedagogical elements during the second lesson in the event.

During the debrief for that lesson she told the pre-service teachers, "You signaled, and this time you waited until everybody was quiet to explain things" (Nora, Lesson Debrief 2, Nov. 2011). Comments during the post interview also indicate Nora's attention to this topic. In describing the lesson she said, "I did notice that a lot of the time [the pre-service teachers] would start lecturing, and they would still have kids chatting, but they would just keep talking" (Nora, Post Interview, Nov. 2011). Other items of attention within this topic were posting of lesson objectives, grouping, timing, and the clarity of the handouts given to the students.

A final area of focus for Nora was student participation and engagement. Nora's comments indicate that she regularly attended to the ways that students were responding to the lesson. When asked to describe what she noticed about the lesson she referred to speaking with the inclusion teacher present during the observation about the students in their classes. She said, "We would notice that the [pre-service teachers] would get one or two of the students who normally don't work to actually work for us, and we were like, 'Oh, that's pretty good'" (Nora, Post Interview, Nov. 2011). She went on to describe what she had noticed about two students who were typically reluctant participants in her class. She said,

> Demetri was starting to work, he doesn't bring his supplies to class. He got a pencil; he was working. And then another kid who sits in the back who never does anything we noticed that he was looking over there at Demetri and we just said, "You know what? Evan is like, 'Maybe I should do this work because Demetri is doing it now.' (Nora, Post Interview, Nov. 2011).

Her comments indicate noticing instances about other students as well. In another example, she describes how her observations of a student provided her with new insight. During the post interview she said, "There was a girl up here, I noticed that she was trying because she usually gives up if she struggles a little bit. I noticed that she can really do it" (Nora, Post Interview, Nov. 2011). Nora's noticing instances during the lesson suggest she also paid attention to which groups were working best and which areas of the room were most actively participating during whole class portions of the lesson.

Lesson event two.

Event two was a one-day lesson taught in February of 2012. A single pre-service teacher taught this lesson to an inclusion Biology class. The objective of the lesson was to present students with various lines of evidence for evolution. The lesson began with a warm up in which students were asked to generate a definition for the term evolution. Then the pre-service teacher showed a video about how scientists used evidence to describe plate tectonics. The students then worked through a series of stations each presenting various types of evidence for evolution. The next activity was a whole class

discussion about each of the activities and the evidence each station presented.

As in lesson event two, general pedagogy remained an area of primary focus for Nora. However, in this lesson event Nora's attention was divided into four areas of secondary focus. As in lesson event one, representation of science content and student engagement were regularly attended to. Additional areas of secondary focus for event two were questioning and assessment as well as student understanding. Pre-service teacher characteristics was an area of limited focus accounting for 5% of Nora's total noticing. There was no evidence of attention to lesson structure or student characteristics during this event. Nora's event two noticing is displayed in Figure 4.14.

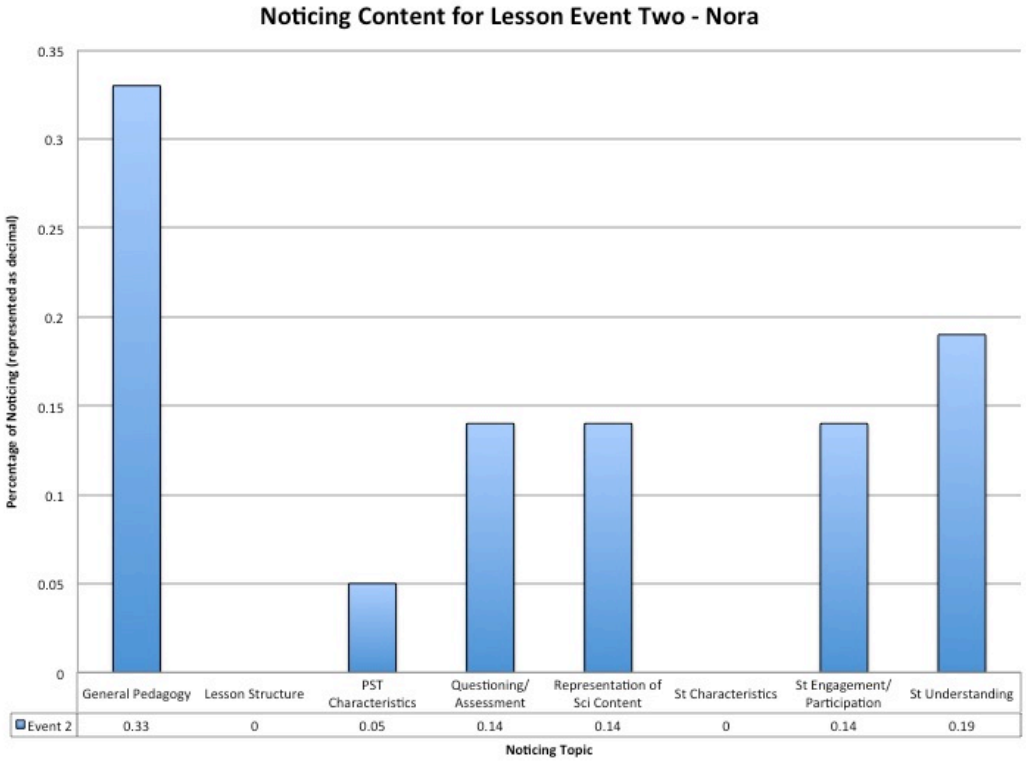


Figure 4.14. Nora's noticing content for lesson event two

As in lesson event one, general pedagogy was an area of primary focus for Nora. Her comments provided evidence of multiple noticing instances in this area accounting for 33% of her total noticing instances during this lesson. Sample comments from the post interview show Nora's attention to calling on students, communicating the lesson objectives, and lesson timing. For example, during the post interview she mentioned noticing that, "[the pre-service teacher] didn't call them by name as often as she probably should have" (Nora, Post Interview, Feb. 2012). She also mentioned that the pre-service teacher "didn't go over the purpose of the activities, she just jumped into them. It would have helped if she would have written the objective on the board and then talked about it with the students" (Nora, Post Interview, Feb. 2012). In a final example for the post interview Nora communicated her attention to the timing of the lesson. She said, "Her timing seemed ok. None of the students seemed freaked out that they didn't have enough time at each of the stations. She did have a lot of extra time at the end" (Nora, Post Interview, Feb. 2012). Nora also noticed the seating arrangement of the students, the preparation of materials, and the use of positive reinforcement by the pre-service teacher.

During lesson event two there were four areas of secondary focus. The following section provides examples of Nora's noticing instances within each of these topics. In terms of the science content, Nora attended to the information in the video shown by the pre-service teacher as well as the content presented in the station activity. In discussing the video Nora said,

> [The pre-service teacher] showed a video on plate tectonics, how scientists came up with that theory, how they used evidence to do that. I liked that she related that to how scientists came up with pieces of evidence that evolution occurs" (Nora, Post Interview, Feb. 2012).

Her comments also show that she noticed the content that the students were exposed to during the station activity. In describing the lesson she said, "The students got into groups and explored the evidence for embryology, they had to sort cards in the order [of development] they thought they went in. I did like how they had to organize the embryos as evidence" (Nora, Post Interview, Feb. 2012).

She also noticed the level of student participation in the lesson. For example, in the lesson debriefs she said, "They were very well behaved for you. There was no redirection. When they got up and started moving they were a little more talkative" (Nora, Lesson Debrief, Feb. 2012). Her attention to this topic was also evidenced by comments in the post interview.

Nora additionally attended to student understanding and the level of questioning and assessment in the lesson. In describing the lesson, Nora's comments illustrate her attention to student understanding. She made comments like, "I remember one of [the students] talking about Pokemon evolving, thank goodness that was cleared up. One kid said, 'Populations evolve' which was good" (Nora, Post Interview, Feb. 2012). She went on to talk about student understanding during the video clip shown at the end of the lesson. In her post interview she said, "At the end [the pre-service teacher] showed a clip

that said, 'we didn't descend from monkeys but we have a common ancestor', but I don't know if all of them understood that we didn't come from monkeys" (Nora, Post Interview, Feb. 2012). She also mentioned this noticing directly to the pre-service teacher during the lesson debrief. She told her, "I hope they didn't leave with a misconception. I think some of them were like oh – we did evolve from monkeys – I think they got that from the video" (Nora, Lesson Debrief, Feb. 2012).

Nora also noticed the type of questions being asked of her students. During the post interview she said, "I would have gone around more and asked higher-level questions while they were working. Try to get them thinking about why do you consider this evidence for evolution?" (Nora, Post Interview, Feb. 2012). She also said, "I think closing with questions is really important. Talking about the pieces of evidence, I think she could have gone over them a little bit better. That's definitely one thing that I noticed" (Nora, Post Interview, Feb. 2012).

Lesson event three.

Event three was a two-day lesson taught in April of 2012. It was taught by the same pre-service teacher and in the same inclusion Biology class as lesson event two. The topic of the lesson was plant structure and function. During the first lesson, the pre-service teacher began with a PowerPoint describing the differences between vascular and non-vascular plants. The students then worked in groups on a project researching the function of various plant parts. After working on their posters, the students presented them to the class. The day one lesson ended with the pre-service teacher summarizing

the information from the presentations.

The lesson on the second day involved a warm up reviewing the information covered in the previous lesson. The students then participated in an activity using microscopes to observe the stomata present on the epidermis of various leaves. Next, the pre-service teacher reviewed the activity and presented various images of leaves. The lesson ended with the students participating in a group activity examining and analyzing different parts of perfect flowers.

General pedagogy continued as an area of primary focus in all lesson events. This area accounted for 21% of Nora's noticing during lesson event three. Other areas of primary focus for lesson event three included the representation of science concepts (25% of total noticing) and student understanding (23% of total noticing). Student engagement was an area of secondary focus (15% of total noticing). The remaining noticing topics were areas of limited focus for lesson event three ranging between 9% of total noticing for questioning and assessment and 2% for pre-service teacher characteristics and lesson structure. Figure 4.15 shows Nora's noticing for this event.

Attention to the representation of science content in the lesson was the most common area of noticing for Nora during event three. For example, during the lesson debrief from the first day Nora said to the pre-service teacher, "I felt like the poster you showed [on parts of the flower] did not do anything. I don't think it was clear that the stamen that produces the pollen and the pistil that uses the pollen to reproduce" (Nora, Lesson Debrief 1, Apr. 2012).

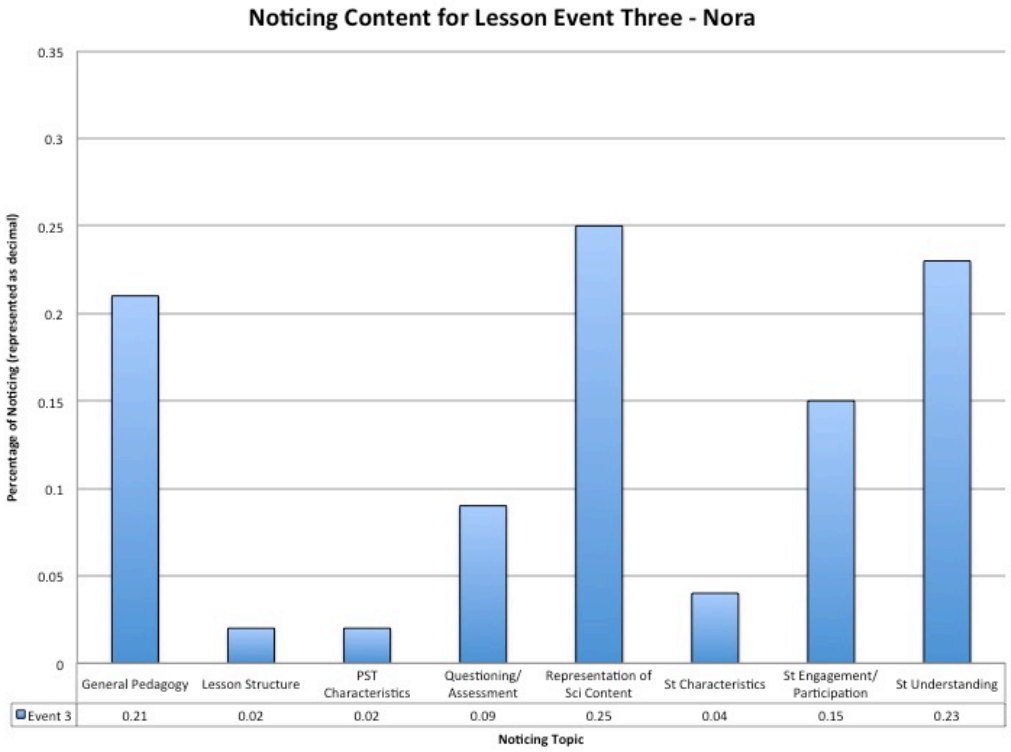


Figure 4.15. Nora's noticing content for lesson event three

The lesson debrief and the post interview both contain frequent reference to the content presented during the second day of the lesson. In the lesson debrief she mentioned to the pre-service teacher that,

> You were showing the graphs with the number of stoma during the time of day. I don't think it was clear which graph was right. I felt that they were both showing the same thing because the sun will impact the temperature and that is going to effect the stoma (Nora, Lesson Debrief 2, Apr. 2012).

She went on to make a comment on her thoughts about the stoma graphs saying, "They were an analysis on stoma, instead of just, 'What is stoma?' So the kids are

having to analyze and look at something, and they have to know what stoma is in order to answer that question which was cool" (Nora, Post Interview, Apr. 2012). The post interview also contained comments describing Nora's noticing about the way in which the pre-service teacher presented content about the plants' functions to her class. In reference to this observation she said,

> [The students] put the functions of the plants on a poster board, and I liked her sticky notes, she had each pair of students write the function of the five parts, and then come up and put each in the correct column and look at the different students' definitions. (Nora, Post Interview, Apr. 2012)

Other noticing instances from day two describe what Nora noticed about the content as she watched the microscope activity. In her comments she noticed that the fact that the students had not made the slides themselves was a drawback of the activity. She mentioned wanting the students to have the experience preparing the slides so that they would understand where the imprint of the stomata they were looking at had come from.

Student understanding was the second most common topic of noticing for Nora during event three. Her noticing in this area was expressed mainly in terms of concern about what the students were taking away from the lesson, especially on the first day. She communicated these concerns to the pre-service teacher during the lesson debrief saying, "I felt like there were a few misconceptions and they weren't clarified. Somebody asked about their being two separate flowers male and female and if [flowers] have both male and female [parts]. Great questions but you didn't answer them" (Nora, Lesson Debrief 1, Apr. 2012).

She also attended to student understanding when watching a discussion take place at the end of day one. In describing what she saw to the pre-service teacher she noted, "You said 'Does anyone know why stoma are important?' There was this little discussion and [the students] thought it was for soaking up water. You can clarify that tomorrow" (Nora, Lesson Debrief 1, Apr. 2012). There were a few instances of Nora noticing positive things about how her students understood the material. One example comes during the post interview when Nora complimented her students saying, "Some of them know quite a bit more than I thought they did. Like information about photosynthesis, they were just spitting it out. They remembered it and I was very surprised" (Nora, Post Interview, Apr. 2012).

Nora's noticing in the area of general pedagogy did not differ dramatically between lessons. Several of the noticing instances that she communicated to the pre-service teacher during the lesson debrief reflect her attention in this area. For example, in debriefing the lesson she communicated what she noticed about the timing of the lesson saying, "You were flexible with time and you will have to do that a lot – change the time- and that was good you were able to do it" (Nora, Lesson Debrief 2, Apr. 2012). As in previous lesson events Nora commented on the use of student names. Other noticing instances within this topic concerned pedagogical elements like the consistent enforcement of class expectations, grouping, and circulation around the room.

As in event one and two, Nora continued to pay attention to student participation in event three. This was an area of secondary focus for her accounting for 15% of her noticing instances. She particularly noticed the times when students were not

participating well during both whole class as well as group activities. For instance, during her lesson debrief from the first day she told the pre-service teacher that, "During the presentations you can tell them to be quiet. I don't think any of them were writing it down" (Nora, Lesson Debrief 1, Apr. 2012). She also mentioned the inattention of particular students. In one example she mentioned an instance of student misdirection that she felt the pre-service teacher did not address. She said, "During your discussion, Everett was like talk, talk and he does that to me, too" (Nora, Lesson Debrief 1, Apr. 2012).

Examples of her noticing participation levels during group work come from her comments about the flower lab on day two. In describing the activity she said, "I noticed that there were six [students] at one of the flower stations and 2 at the other. The six that were at one station, half were goofing off. The station of two students was working really hard" (Nora, Lesson Debrief 2, Apr. 2012). She also mentioned this noticing during the post interview. These comments represent typical examples of Nora's noticing on this topic.

Nora's noticing trends.

Nora's case is unique in that she is the teacher in the study with the least teaching experience. She is also the only teacher in the study conducting her observations in an inclusion setting. A picture of Nora's noticing over the three lesson events is presented in Figure 4.16. The graph shows the percentage of total noticing within each noticing topic for lesson events one, two and three.

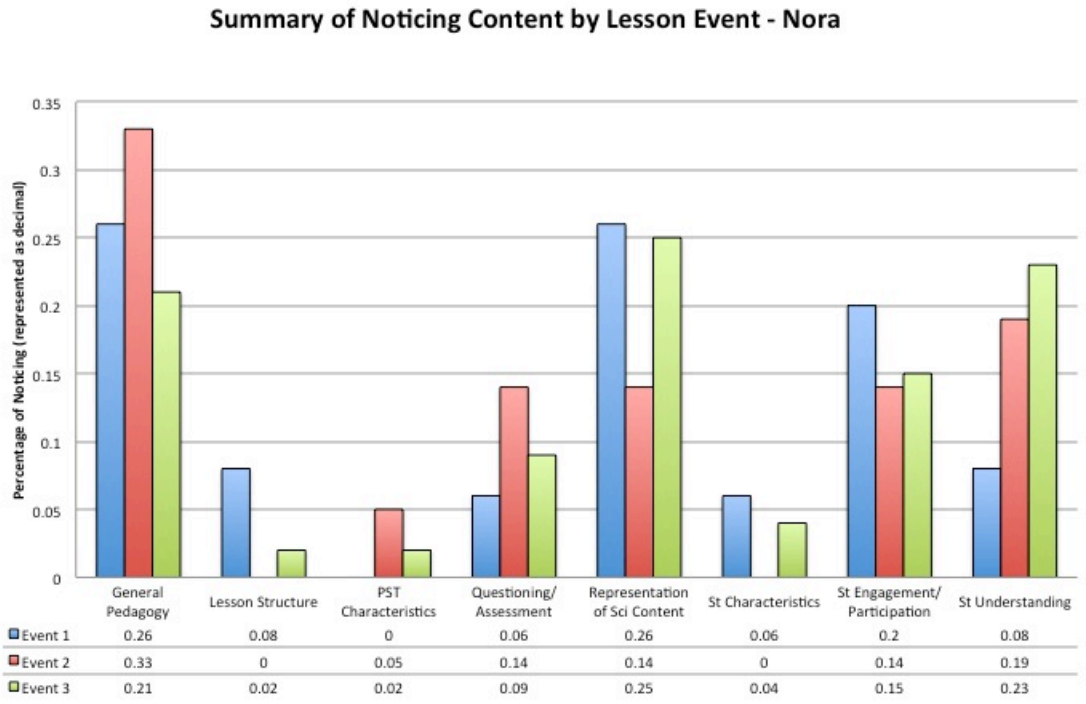


Figure 4.16. Summary of Nora's noticing content by lesson event

Nora primarily attends to general pedagogy across lesson events. She also commonly notices elements of the science content being presented as well as the participation and engagement level of her students. Though a limited focus in the first event, student understanding was a secondary focus in the second event, and a primary focus during the last event.

Questioning and assessment was an area of focus only during the second event and received limited attention during the other two events. The noticing topics of lesson structure, student characteristics, and pre-service teacher characteristics received limited

attention during some lessons and we received no attention in others. Table 4.4 shows the focus of Nora's noticing by lesson event.

Table 4.4. Nora's noticing by areas of focus across lesson events

Focus	Lesson Event 1	Lesson Event 2	Lesson Event 3
Primary	General Pedagogy Science Content St. Engagement	General Pedagogy	General Pedagogy Science Content St. Understanding
Secondary		Question/Assessment Science Content St. Engagement St. Understanding	St. Engagement
Limited	Lesson Structure Question/Assessment St. Characteristics St. Understanding	PST Characteristics	Lesson Structure PST Characteristics Question/Assessment St. Characteristics
Not Noticed	PST Characteristics	Lesson Structure St. Characteristics	

CROSS CASE ANALYSIS

The individual cases have described the content of each science teacher's noticing over the course of three lesson events. The following section will describe the trends in their noticing. It will also provide evidence that teachers engage in pedagogical reasoning and make connections to their own practice through the act of noticing and feedback giving.

The content of cooperating science teacher noticing – What they notice.

The first research question in the study asked what science teachers notice as they observe pre-service teachers enacting lessons in their classrooms. The case studies presented provide a detailed description of the content of each teacher's noticing. The data presented in the case studies shows that the content of science teacher noticing varied between lesson events.

However, when data from lesson events is combined, teacher noticing across topics was more consistent. Figure 4.17 shows cumulative noticing over the course of the three lesson events organized by topic and by teacher.

Overall, teacher noticing for these four cooperating science teachers displays a continuum of noticing. On the high end are the categories of general pedagogy and representation of science content consistently receiving over 20% of teacher attention. Student engagement and student understanding each consistently represented over 10% of teacher noticing instances. These categories accounted for an average of 16% and

15% of teacher attention respectively. Noticing topics consistently receiving less that 10% of teacher attention included questioning and assessment, lesson structure, and student characteristics. Pre-service teacher characteristics was the topic given the least attention with an average of 4% of teacher noticing falling into this category.

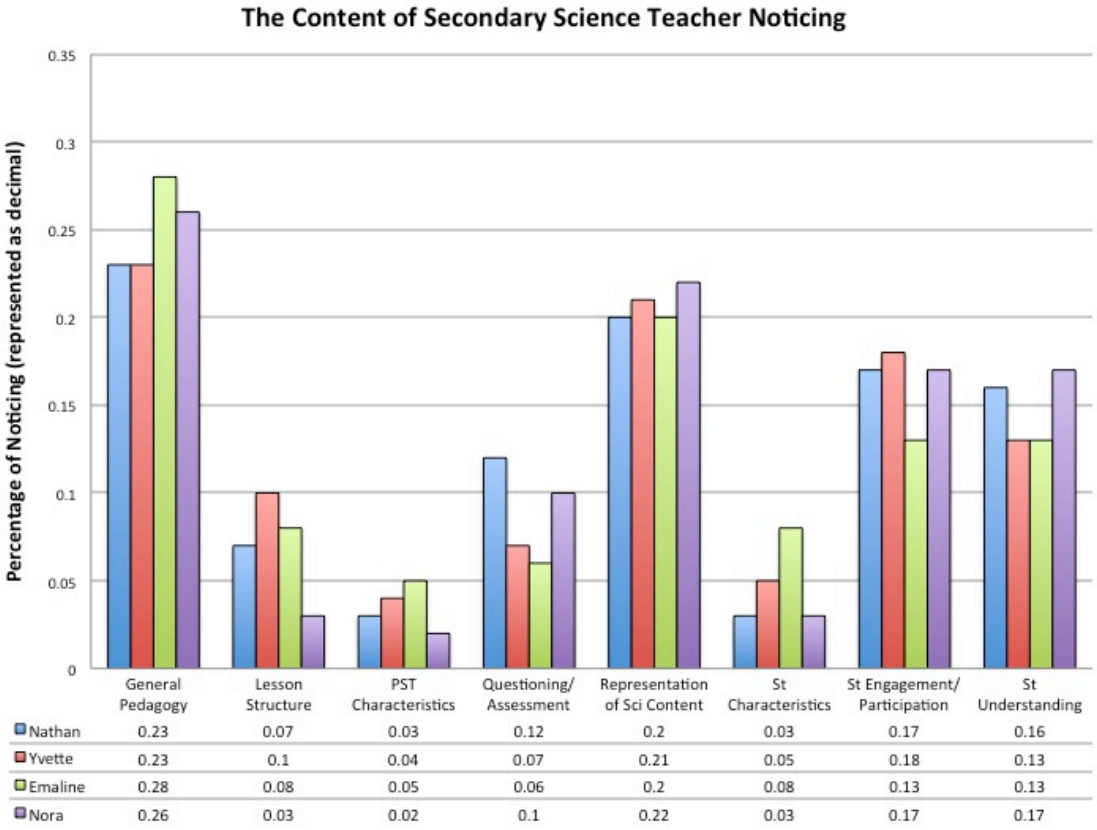


Figure 4.17. Content of secondary science teacher noticing

When further aggregated, additional trends emerge from the data. Figure 4.18 depicts teacher noticing broken into three broad areas of focus: the lesson, the pre-service teachers, and the students. Noticing topics included in the category of focus on the lesson

included general pedagogy, questioning and assessment, lesson structure, and presentation of science content. The category of focus on the student included topics of student engagement, student characteristics, and student understanding. Since attention to the pre-service teacher's characteristics did not align well with either of these categories it was left as its own category.

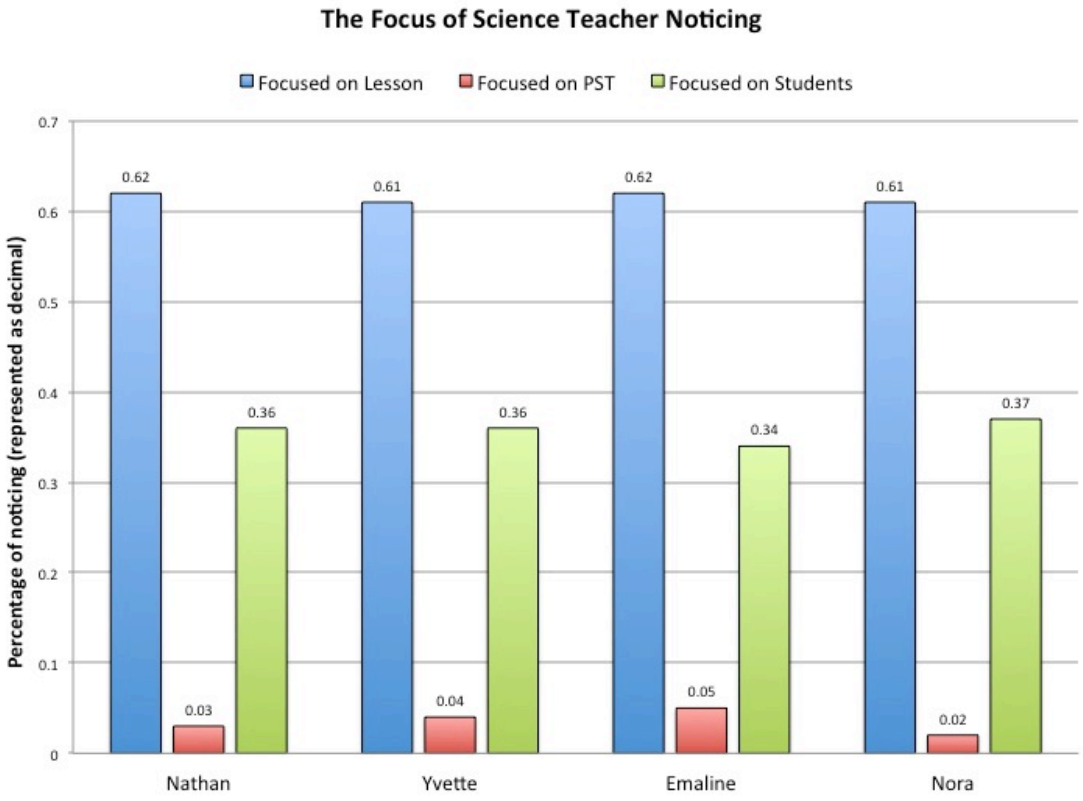


Figure 4.18. Focus of secondary science teacher noticing

The graph depicts how frequently each teacher's noticing fell into each of the three categories. The four teachers studied all focused between 61-62% of their noticing on elements of the lesson being enacted. General pedagogy and presentation of the

science content make up the majority of attention in this area for all teachers accounting for 75% of their lesson focused noticing instances. The cooperating science teacher also focused attention on their students. Between 34-37% of teacher noticing were in this area. Student engagement and student understanding accounting for 86% of student focused noticing instances.

The structure of science teacher noticing - Evidence of pedagogical reasoning.

The second research question in the study asked if the act of noticing stimulates pedagogical reasoning in the cooperating science teacher. Analysis of the structure of their noticing provides evidence that the cooperating science teachers in this study regularly engaged in pedagogical reasoning and reflection through the work of observation and providing feedback for pre-service teachers. Communication of their noticing provides evidence that these teachers engage in pedagogical reasoning by evaluating the events they are watching, interpreting they events that they notice, and using this information to suggests transformative actions to improve the lesson.

Individual noticing instances frequently included more than one element of pedagogical reasoning. For example, in the comment by Emaline during a lesson debrief occurring after lesson event three she says,

> You did a good job walking around and checking on [the students] work during warm up. Sometimes I will just leave them to sit and it is not the most beneficial. You coming around helping is making them feel more successful and helping

them get engaged. (Emaline, Lesson Debrief 2, Apr. 2012)

This comment provides evidence that Emaline was evaluating the actions of the pre-service teacher and making an interpretive comment about his actions by telling him that he is helping the students feel engaged. Similarly, a comment from Nathan contains multiple noticing elements. In his interview after lesson event one Nathan said,

> I was thinking that (the pre-service teachers) might have been given the students some information that was related to the Lewis Dot Structures and have them interact with that in a way that either caused them to retell it, rewrite it, some way to have them do it on their own. In learning, I think kids need least six exposures to new material before it sticks (Nathan, Post Interview, Nov. 2011).

Nathan started this comment by making a transformative suggestion for the lesson. He made sense of his suggestion through the interpretation that students need multiple exposures to new material. These examples illustrate how multiple elements of noticing structure can be communicated within a noticing instance.

Evaluation.

Analysis of the structure of science teacher noticing provides evidence that these teachers engaged in pedagogical reasoning through the act of evaluation. An evaluative element in a noticing instance was indicated by the presence of evaluative terms such as "good" or "nice." Evaluation could also be indicated by phrases such as "I like how …" "I was happy with …" etc. Evaluation was the least common structural element

communicated by these four teachers. The high end of the frequency of this element was 27% (Nathan) and the low range was 17% found in the noticing of Yvette. A typical example of an evaluative statement comes from Nora's lesson debrief after lesson event three. After watching a lesson on plant structure she commented to the pre-service teacher, "I liked that you talked about the difference between the vascular and non-vascular and before you told them you asked them, 'Why did you choose vascular or non vascular?' and the students came up with some good ideas." (Nora, Lesson Debrief 2, Apr. 2012)

This comment illustrates Nora evaluating the way the pre-service teacher presented the material and also making a value judgment about her students' responses. It is noteworthy that this group of cooperating teachers rarely used negative evaluative terms such as "bad" or "I didn't like" either in the lesson debriefs or in the interviews. Noticing instances in which teachers seemed dissatisfied with what they saw were communicated almost exclusively through interpretive comments and transformative suggestions.

Interpretation.

Interpretation was the most common element of pedagogical reasoning present in the data. Interpretation was indicated when a teacher described the way he or she was making sense of what they had observed or suggested. The frequency of teacher noticing instances that included interpretive elements ranged from 48% (Nora) to 71% (Emaline). An example of a noticing instance containing an interpretive element comes from the

lesson debrief for event one. During the lesson Emaline noticed that one of her students seemed to be confused and she interpreted this to mean that many of her students were confused. In her comments to the pre-service teachers she said, "I noticed that Rick was having a hard time understanding what you meant by least amount and you did a good job of going back and clearing that up. When one kids has a misunderstanding it is likely that 5 or six others are to." (Emaline, Lesson Debrief 2, Nov. 2011). Another example of interpretation comes from Yvette during a lesson debrief following event two. After watching a lesson on aquatic ecosystems Yvette said to her pre-service teachers,

> You had good questions, they were thought-provoking. I would suggest having the questions written down, because some kids need more time to think. When somebody's hovering over them they are like 'I don't know' and Ana won't answer and things like that." (Yvette, Lesson Debrief, Feb. 2012)

In this comment Yvette noticed that Ana was not answering the lesson questions and she interpreted the reason for this to be that her students need the questions in a written format and that they needed more time to think about the questions.

Transformation.

Teacher comments demonstrate the teachers frequently used their noticing to engage in transforming the lesson they observed. In a noticing instance with a transformative element the teacher would make suggestions for how the lesson should be changed or suggest alternative strategies to try. This transformative element was present in over a third of the total noticing instances. The range for this element was 35%

(Nathan) to 44% (Nora) of total noticing instances.

One example of a noticing instance containing a transformative element comes from Yvette. During lesson event one, Yvette watched an activity where students were exploring Chargaff's Rule and the percentages of various nitrogen bases in a DNA model. After the lesson she made a transformative suggestion about how the lesson might be changed and why the change would be beneficial. In her post interview she said,

> When calculating the percentages, (the pre-service teacher) was doing it in her head and it just telling [the students]. I think if they could have easily had the kids figure it out themselves. Let the kids think. If the kids can solve the problem, make their own connections, then it's going to last longer in their heads than the teacher just telling them how to do it" (Yvette, Post Interview, Nov. 2011).

Another instance is found in Nora's comment after watching a lesson on plant structure. She said to her pre-service teacher, "When Ronaldo asked, 'Isn't there a plant whose roots go deep in the ground to find water?' that would have been a good time to connect to adaptations of plants. You could have asked him, 'What type of environment would a plant need deep roots?'" (Nora, Lesson Debrief 1, Apr. 2012). This noticing instance shows that Nora attended to her student's question and reasoned about specific ways the pre-service teacher's response to the question could have been improved. A final example comes from Nathan's post interview from lesson event one. During the lesson on electron configuration students were each assigned a different element, asked to create posters showing different representations, and then asked to explain their posters to

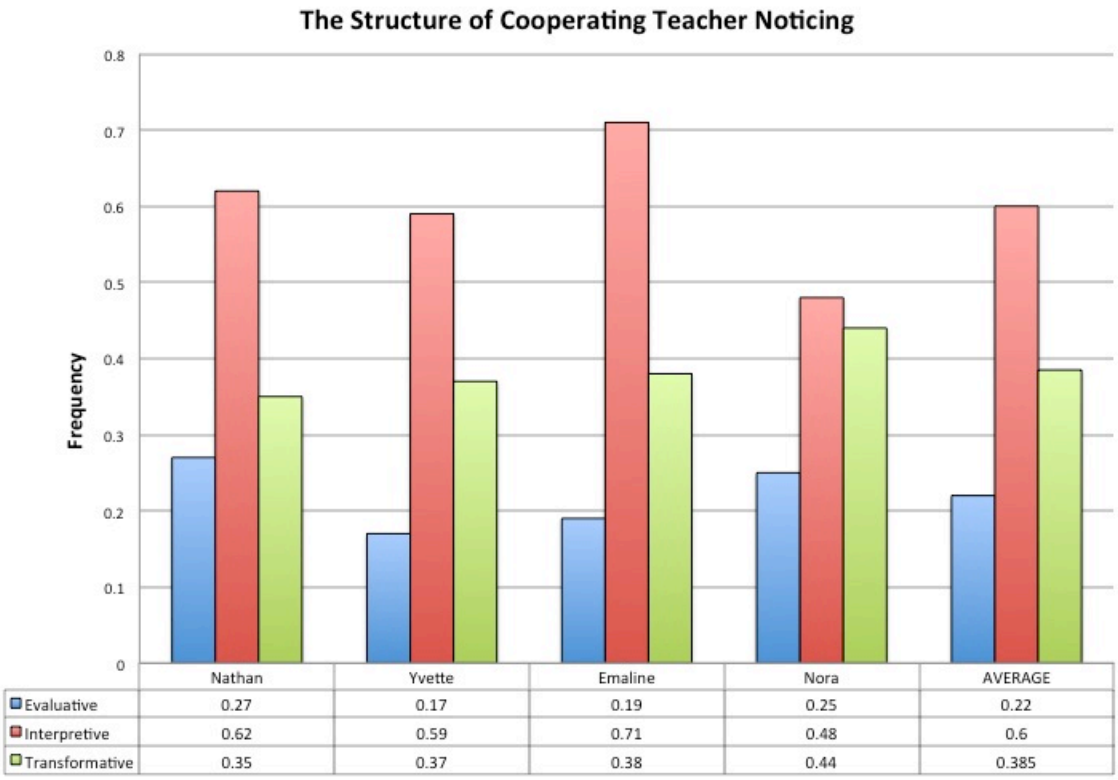
the class. In his interview Nathan commented,

> I was walking around when they were in groups and watching their presentations. I wrote down a note. How could you have students signify valence electrons in each part of the poster? That is an important thing to do because it depends on energy level. There may be something they [the pre-service teachers] could have done to say color where you think the valence electrons are, in the orbital model, in the Bohr model. (Nathan, Post Interview, Nov. 2011)

In this noticing instance Nathan is questioning the way the science content was being handled, reasoning about his observation, and suggesting a way to revise the lesson.

Trends in the structure of cooperative teacher noticing.

Figure 4.19 depicts the frequency of evaluative, interpretive, and transformative elements in the noticing instances of the four study participants.



	Nathan	Yvette	Emaline	Nora	AVERAGE
Evaluative	0.27	0.17	0.19	0.25	0.22
Interpretive	0.62	0.59	0.71	0.48	0.6
Transformative	0.35	0.37	0.38	0.44	0.385

Figure 4.19. Structure of cooperating teacher noticing

As a whole the structure of cooperating science teacher noticing was similar across teachers and events. On average, 22% of noticing instances contained an evaluative element, 60% contained an interpretive element, and 39% contained a transformative element. This data suggests that teachers are regularly engaging in pedagogical reasoning through the act of noticing.

Analysis of the noticing data also showed that teachers in this study engaged in pedagogical reasoning across noticing topics. For example, Nora's noticing of Ronaldo is an example of her engaging in pedagogical reasoning within the area of questioning and

assessment. In contrast, Nathan's noticing gives an example of his pedagogical reasoning as he attends to the representation of the science content. Figure 4.20 gives a breakdown of the percentage of total noticing within a particular noticing topic that contained elements of pedagogical reasoning.

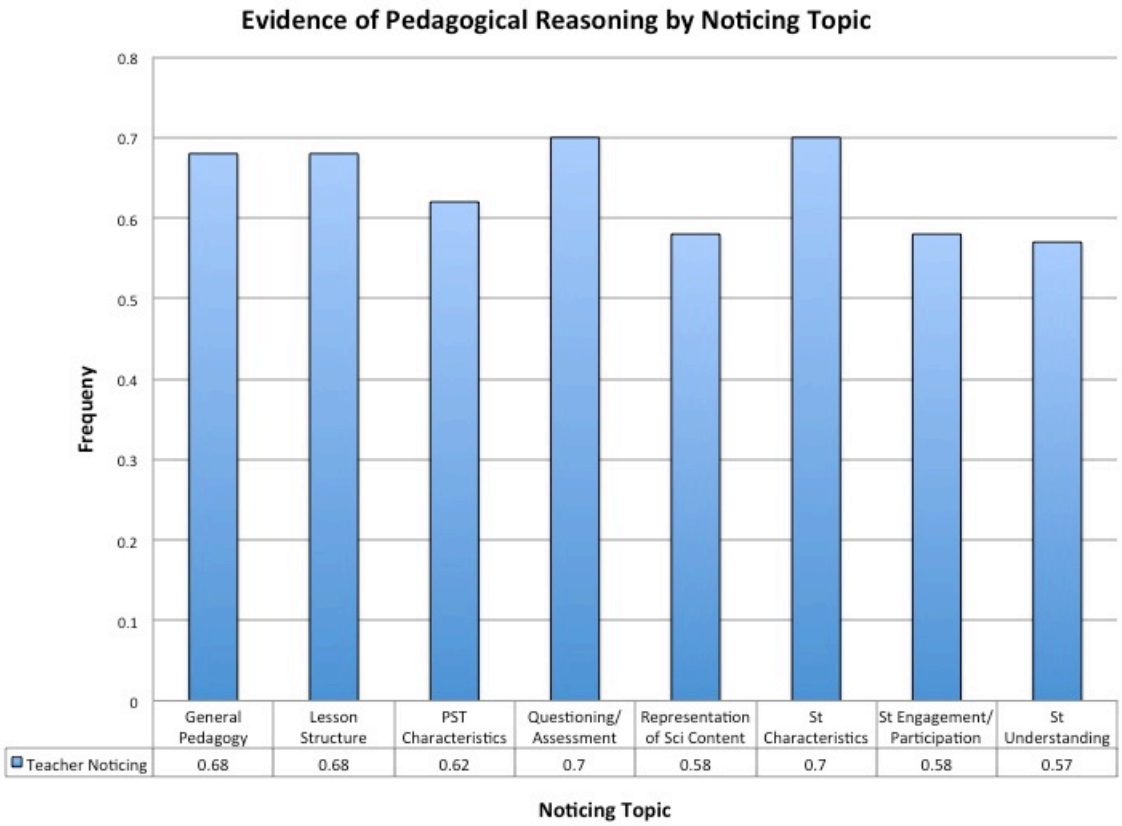


Figure 4.20. Evidence of pedagogical reasoning across noticing topics

Teacher comments showed evidence of pedagogical reasoning in more than half of their total noticing instances. As a whole, the range of the noticing instances within a

topic that included one or more evaluative, interpretive, or transformative element ranged from 57% within the topic of student understanding to 70% in the areas of student characteristics and questioning and assessment. This data illustrates that teachers engage in pedagogical reasoning through the act of noticing regardless of the content of the noticing.

Teacher noticing and connections to practice.

The final question in the study asked what, if any, connections teachers draw between their noticing and their own teaching practice. In analyzing the noticing of the cooperating science teachers there is evidence that teachers regularly make connections to their own practice as they observe pre-service teachers. Yvette's noticing instances contained the fewest connections with 23% of her total noticing including a reference to herself or her practice. Nora and Nathan made connections to themselves in 30 and 33% of their total noticing instances respectively. Emaline's noticing showed evidence of connection in 39% of noticing instances. Within teacher noticing, evidence of these connections manifested in several ways: vicarious suggestions, reflective questions, a comparison of practice, and reported insights gained from new perspective.

Vicarious suggestions.

One way a connection to self may occur is in the form of vicarious suggestions. In a vicarious suggestion, the teacher discusses the lesson with him or herself as the subject.

For example, teachers may suggest transformative actions while placing themselves in the role of the pre-service teacher. Comments of this kinds often start with the phrase 'I would ….' followed by a suggestion intended for the pre-service teacher. Unlike suggestions that start with "You should…", these vicarious comments illustrate that the teachers are connecting with the experience they observed by envisioning themselves teaching the lesson.

One example of a vicarious suggestion can be found during Nora's lesson debrief after event two. She had watched the pre-service teacher conducting a lesson on evolution in which the students moved around to different stations to analyze various types of evidence. In considering the activity she said, "You had four probing questions at each station for the students to think about. I would add these so that when they are at each station they can think about the questions or write their answer on the packet" (Nora, Lesson Debrief, Feb. 2012). Another example comes from Emaline's noticing during lesson event one. During the lesson debrief she made a suggestion about the lesson saying, "I think I would have called everyone to the board at once, have everyone draw their models, and then have them sit back down and go over it. This would get more students participating at once." (Emaline, Lesson Debrief 2, Nov. 2011) These examples illustrate Nora and Emaline placing themselves in the role of the pre-service teachers and describing actions they would take.

Reflective questions.

A connection to their own teaching practice is also evidenced by instances of

reflective questions that the teachers ask of themselves during the lesson debrief or interview. At times these questions about their practice remain unanswered and in other instances they are followed by possible actions they might take. In the lesson debrief from event two, Nathan ponders whether a more directed or open-ended approach is better for his students. In debriefing with his pre-service teacher he says, "If you are going to use this applet can you have done an example and asked them 'What do you notice differently about endothermic and exothermic?' They could have gotten through that activity more quickly. I don't know…is there a trade off having them figure it out on their own versus making it very clear?" (Nathan, Lesson Debrief, Feb. 2012). Similarly, the process of noticing stimulated reflective questions from Yvette. A comment during her post interview from event one reveals these questions. She says,

> This lesson in particular made me realize the importance of going over the why. Why do I care about my students knowing these facts? Why do we care? We have to allow time for the kids to understand why we're teaching something, why is it important" (Yvette, Post Interview, Nov. 2011).

In Nathan's case the reflective question remains something for him to ponder. In Yvette's case she seems to reason through her own question and suggest a solution.

Comparison of practice.

A common way of teachers making connections to their practice is in the act of comparison. Comments made during lesson debriefs and interviews show that teachers reflect on what they notice during the lesson and make explicit comparisons to their own

work. This reflection results in either a confirmation of the strategies they are currently using, a discussion of areas that they need to work on, or an indication of changes they plan to make. All of the teachers in this study made comparisons of this type during the communication of their noticing.

In considering a DNA lesson she observed, Yvette told the pre-service teacher,

> I like that you had more nucleotides [in the DNA model] because the model I use only has the same set of four bases for each student and you are right when we put them together as a class it is the same repeating units [throughout the strand] and that's not accurate (Yvette, Lesson Debrief 1, Nov. 2011).

This comment demonstrates the Yvette is comparing the DNA model that she uses with the model used by the pre-service teacher. In this case she has decided that their model is a more accurate representation of this aspect of DNA structure than her own.

Nora also compares her current practice with what she observers her pre-service teachers doing. In the lesson debrief for event three, she gives her pre-service teacher some advice saying, "During the discussion you just stood at the front. Try to circulate and walk around. When you have the picture of the stoma up on the screen you can stand behind the students and talk about it, they can still hear you. I don't like standing behind the desk, it is so far from everyone. I always try to circulate and it works" (Nora, Lesson Debrief 1, Apr. 2012). In this case Nora has decided that her current pedagogical actions have advantages over what she has observed.

An additional instance of comparison of practice comes from Emaline. After watching a lesson on the molecular geometry of chemical compounds, Emaline

connected what she saw to her own methods of presenting this information. She first mentioned noticing the models that the pre-service teachers used during the lesson debrief. She said to them, "The 3-D model was great. Perhaps give them choices for which model matched with the name and then ask them to justify their ideas" (Emaline, Lesson Debrief 2, Nov. 2011). She elaborated on this noticing during her post interview when she said,

> After watching the lesson I was like ok, I need to start with models, have some choices, and talk about what vocabulary do [the students] already know? If I put the choice up, a model, it gives them something to see, to make sense of…and then they can at least justify it in their thinking. So I'll do that. I am also going to have them build models like they did today" (Emaline, Post Interview, Nov. 2011).

Emaline compared her current practice with that of her pre-service teacher's and decided that pairing modeling with the introduction of vocabulary is a new strategy she wants to try.

In final example, Nathan compared the way he and the Chemistry department at his school present the information on thermochemistry to the methods employed by the pre-service teacher. During a post interview he commented,

> [The pre-service teacher] took a subset of thermochemistry out, endothermic and exothermic, which is really one small aspect. That reminds me to break it up when I teach it. The way that our notes are structured in the curriculum here, they go over endothermic, exothermic, Hess's Law, and the specific heat equation. It

goes over all of that information all in one lesson. When you're giving [the students] it all in one chunk you don't get nearly as much of the recall" (Nathan, Post Interview, Feb. 2012).

During lesson event three, Nathan reflected on his questioning strategies. In thinking about the way the pre-service teacher posed questions to the students Nathan said,

> When I saw [the pre-service teacher's] questioning style I thought maybe there are things that I could change. There was a moment where he was asking a student about the polarity of water. He replied to her, 'Well you're half right.' And then he went on to another student. He didn't tell her what half was right, which I would do. So I thought, wow, maybe it's not a bad thing to think about leaving some answers this way because he was asking similar questions to the rest of the students, until he could bring it all back home again. So really kind of keeping that cognitive dissonance. Where they know they don't know, they're not really sure what's going on, to really get them thinking and engaged about it (Nathan, Post Interview, Apr. 2012).

In this example, Nathan is comparing his questioning technique to that of the pre-service teacher and considering the impact on his students.

Perspective shift.

Finally, the act of noticing fostered connections to practice through the insight that teachers gain when watching their classroom from a new perspective. The teachers in

the study reported that they experiencing the lesson as an observer, rather than an instructor, provided them with the opportunity to observe classroom dynamics from a new point of view. The things that they noticed, particularly about their students, often fostered reflection and thoughts about their own teaching practice. One example of this comes from Yvette's post interview after lesson event one. During this lesson, Yvette sat at the lab group with her students as they worked through the process of DNA replication. She did not talk with them but simply observed and she later commented,

> I was sitting with a lab group and the kids were talking about the nucleotides being recycled and about how they come together reminding them of a magnet. That makes me want to have my kids to come up with their own analogies more frequently. Because I think that could be really powerful and help them come up with ways to think about this. Those are things that they came up with. Those weren't things that I told them. (Yvette, Post Interview, Nov. 2011)

This quote illustrates how Yvette's noticing about her students led her to make a connection to a new teaching strategy she would like to try.

Emaline also gained insight from watching her students and connected her noticing to the visual representation she has used when talking about atomic structure in the past. In the debrief after an event two lesson on VSEPR she commented to her pre-service teacher,

> I could see that [the students] could not remember whether the spheres in the model were electrons or atoms. It was really interesting to me. I realized that part of it is that we represent a ton of stuff with Chemistry with circles. When we talk

> on the subatomic level we use circles, when we go to atomic we use circles, intermolecular we still use circles. I am telling you this because it has taken me six years of teaching and watching today to realize that for them this is a lot of circles and it is really confusing for them. I am going to have to change how I am representing things – I am going to really have to think about how I symbolize things. When Ernesto was explaining himself up there – he could not decide if they were electrons on atoms. I could see him struggling. So thank you" (Emaline, Lesson Debrief, Feb. 2012).

This example demonstrates that Emaline's noticing about Ernesto led to her considering changes to they way she will present this content to her students.

Additional examples include both Nathan and Nora making observations about their students working in established lab groups. Based on what they noticed, they each decided that they wanted to change the make up of these groups. In another example, Emaline noticed the height of her lab stools and the access they provided to the work area. This noticing was followed by an indication by Emaline that she was planning to replace the lab stools in her classroom. In watching the dynamics of their classroom, including student interactions, the resources of their classroom, and the physical space from a new perspective, teachers in this study came to new realizations about their own practice.

SUMMARY

In summary, this section has presented a case study of the noticing of four

different science teachers. The cases describe teacher noticing over a series of three lesson events. Though teacher noticing varied between individuals and events there was evidence that the content of teacher noticing was consistent among teachers when aggregated across lesson events. During observations, the science teachers in this study primarily attended to the areas of general pedagogy and representations of science content. They secondarily attended to student engagement and student understanding. They paid limited attention to the areas of questioning, lesson structure, student characteristics, and pre-service teacher characteristics.

The findings also show that these teachers engaged in pedagogical reasoning during the act of noticing through the processes of evaluation, interpretation, and transformation of the lessons they observed. The study illustrates that the act of pedagogical reasoning occurred across noticing topics suggesting that teachers engage in this act independent of noticing content. Finally, findings showed that teachers made connections to their own practice during the act of noticing. These connections appeared as vicarious suggestions, reflective questions, comparisons of practice, and perspective shifts that provided insights through a new view of the classroom.

Chapter Five: Discussion and Implications

Attention to secondary science cooperating teachers is a gap in the current research on teacher learning and professional development. This study adds to the literature by investigating this understudied yet important group. During their work as cooperating teachers, these science teachers engage in the act of observation, reflection, and discussion; activities shown to facilitate learning.

The purpose of this dissertation is to explore what cooperating science teachers attend to during observations of pre-service teachers providing instruction in their classrooms and how they make sense of what they see. Investigating what cooperating teachers notice and how they interpret their noticing is important to better understanding their instructional reasoning. Since cooperating science teachers play a critical role in teaching students, mentoring pre-service teachers, and in the leadership of their schools and districts, a deeper understanding of their practice is valuable.

The study participants included four cooperating science teachers serving as mentors for pre-service teachers during an early field experience in an urban secondary setting. The science teachers had a range of experience in both teaching and mentoring. The research was conducted over the 2011-2012 academic year and data for the study was collected over five observed lessons organized into three lesson events. It is important to recall that lesson events varied from each other in several ways (e.g. science content presented, length, the pre-service teachers, class period) and therefore they should not be considered equivalent experiences. Instead, these events should be considered

distinct snapshots of cooperating teacher noticing in the secondary science context.

During each lesson enacted in their classroom, the secondary science cooperating teachers were asked to record their noticing and then discuss their thoughts during lesson debriefs and interviews. Participant comments were used to identify and describe the nature of noticing for each teacher. A written noticing form as well as field notes from classroom observations provided supporting evidence to accompany teacher comments. The open-ended nature of the data collection methods used during this study served to expose the intricacies of teacher attention in this setting. In reviewing findings on teacher noticing found in mathematics education, Schoenfeld (2011) asked about the context specific elements of teacher noticing. While the noticing in this study took place in various classroom contexts, the findings can contribute to understanding to the nature of teacher noticing in a new context, specifically the secondary science classroom.

The framework for this chapter includes an explication of the findings from Chapter 4, discusses the findings in light of the current literature, presents implications of the study findings, and suggests future lines of research for the field of science education.

EXPLICATION OF THE FINDINGS

Noticing content.

The first research question asked what teachers notice when they watch science lessons enacted with their students. Analysis of the data revealed that teachers attended to a variety of topics during their lesson observations. These topics included general

pedagogy, lesson structure, pre-service teacher characteristics, questioning and assessment, representations of science content, student characteristics, student engagement, and student understanding of the content. The case studies presented in this study describe that the content of teacher noticing for each teacher was variable between lesson events. This was likely due to the content of the lesson being observed as well as the nature of the tasks the students were asked to engage in.

Though individual teacher noticing was shown to vary by lesson event, when taken together, the data revealed trends in teacher noticing both within and across participants. In general, the largest portion of cooperating science teacher attention was directed to general pedagogy and representations of science content. During their observations science teachers also attended to student participation and engagement, and student understanding of science concepts. Overall, less participant attention was directed to questioning and assessment, lesson structure, and specific student or pre-service teacher characteristics. Additional consistency was found when noticing instances were further aggregated into three broad categories: attention to the lesson, attention to the students, and attention to the pre-service teachers. Analysis at this broader level showed approximately two-thirds of teacher noticing instances focused on elements of the lesson, in contrast with approximately one-third of their attention on their students. Only a very small portion of teacher attention was directed at personal characteristics of the pre-service teachers teaching. This pattern was consistent across teachers and lesson events.

Noticing structure.

The second question in the study asked if the act of noticing stimulated pedagogical reasoning in the cooperating science teacher. Data to answer this question was found in characterization and analysis of the structure of teacher noticing. Teacher noticing instances were found to include several components of pedagogical reasoning including evaluation, interpretation, and transformation. The presence of these structural elements varied in frequency by teacher. Interpretation was the most common element of pedagogical reasoning present in the noticing of cooperating science teachers. This was followed by transformation and evaluation.

It should be noted that the evaluative comments coming from the cooperating teachers were most frequently positive. Any negative impressions were almost exclusively communicated through interpretive comments and transformative suggestions. This suggests that perhaps the act of evaluation was occurring more frequently that the data would imply. It is possible that cooperating teachers held back negative evaluations in an effort to be supportive of the pre-service teachers. This sentiment may have also influenced written noticing even though the pre-service teachers did not have access to the noticing form. As in the verbal comments, there were very few examples of explicitly negative noticing instances present on these forms.

In addition, the data revealed that science cooperating teachers engaged in pedagogical reasoning across lesson events and noticing topics. The range of noticing instances containing evidence of pedagogical reasoning was at a high when teachers

attended to student characteristics and questioning and assessment. The low side of the range occurred when teachers were attending to student understanding. While one might find it somewhat discouraging to note the drop in pedagogical reasoning with regards to student understanding, the overall findings show that teachers engage frequently in pedagogical reasoning. And, that even at the lowest levels, teachers are reasoning about their observations more often than not.

Connections to self.

The third question asked if cooperating science teachers drew connections between their noticing and their own teaching practice. The study found that teachers regularly made connections of this type. On average over 30% of teacher noticing instances contained evidence of teachers drawing connections between their observations and their own science teaching. These connections were manifested in the form of vicarious suggestions made to pre-service teachers, reflective questions the cooperating teachers asked of themselves, comparisons made between their own actions and that of the pre-service teachers, as well as through shifts in perspective about their classroom and students. It is important to highlight that the classroom context played an important role in mediating the nature of the connections teachers were able to make. The science teachers in the study often connected to their own practice through noticing their own students as well as the resources, course content, and classroom dynamics specific to their own instructional setting. Connections of this kind are uniquely available in the context of a teacher's own classroom.

CONNECTIONS TO THE LITERATURE

On teacher noticing.

In accordance with research on noticing in other content areas (Erickson, 1980), data from this study suggests that cooperating science teachers pay attention to specific elements of the classroom and attend to a wide array of topics. In this study the range of topics noticed spanned the areas of general pedagogy, content representations, and student behaviors. Additionally, research has suggested that noticing is teacher specific and highly variable (Erickson, 2011). In support of this, teacher noticing in this study was shown to vary both within and between teachers for individual lesson observations. This suggests that numerous factors influence teacher noticing. Factors including the content of the lesson, the presence or absence of various students, the nature of the tasks being observed, the teachers emotional response to the lesson, and so on, are likely at play in accounting for this variation.

While individual variation was present, the findings from this study demonstrate that cooperating science teacher noticing showed several areas of consistency when aggregated across lesson events. The cooperating science teachers in this study attended to general pedagogy and representations of science content more than on other noticing topics. Additionally, these teachers focused primarily on elements of the science lesson being presented and secondarily on their students. In this way, this study adds to the literature by revealing consistency in secondary science teacher noticing when analyzed broadly.

Furthermore, this study was able to characterize the nature of noticing for secondary science cooperating teachers, not only in terms of content but also in terms of structure. This builds on the work of van Es (2011) that also characterized noticing along these two lines and adds to the her work by shifting context from an elementary mathematics setting to a secondary science setting. Comparison between the two studies reveals some similarity in teacher noticing across subject areas. As in the van Es study, teachers in this study attended to pedagogy and student understanding. However, this study articulated additional topics of focus including representations of content, student engagement, question and assessment, student characteristics, and pre-service teacher characteristics. The van Es study also showed that teachers could be prompted to focus on particular aspects of a lesson and that this prompting changed both the content and form of teacher noticing over time. Since prompting of this kind was not provided for the cooperating science teachers in this study, the overall structure of their noticing showed no directional change during the course of the year. This confirms that the refinement of teacher noticing is not an organic process but one that requires intentionality in designing the prompts and activities used to focus teacher attention.

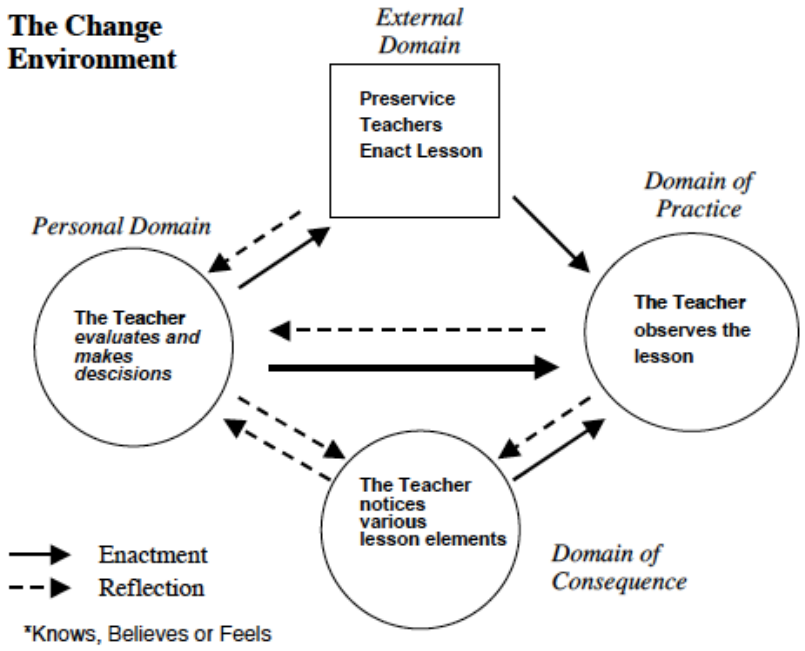
Finally, Schoenfeld (2011) asked for exploration of the different trajectories of noticing for teachers with different levels of experience. Findings from this study have shown that, in a broad sense, an overarching pattern for both the content and structure of the noticing of the participants could be identified. This pattern was consistent regardless of years of experience in teaching or mentoring. It should be noted that all of the teachers in this study had at least three years of teaching experience and some previous experience

as a cooperating teacher mentor. Perhaps the newest teachers in the field, those with less than 3 years of teaching experience, would have a different noticing pattern. It is also possible that new mentors would approach the observation process differently and therefore notice different elements than the teachers in this study.

Noticing as professional experimentation.

Findings from this study suggest that cooperating science teachers use noticing as an opportunity to engage in professional experimentation. Professional experimentation was articulated in a description of an interconnected model of professional growth (Clarke and Hollingsworth, 2002). Figure 5.1 provides an image of how this model has been adapted for noticing in classroom observations of pre-service teachers.

Figure 5.1. The interconnected model of professional growth adapted for classroom noticing



In this figure, the external source of information comes from the lessons brought in by the pre-service teachers. The domain of practice involves pre-service teachers enacting lessons as a proxy for the cooperating teacher's own instruction. The teachers in this study seemed to intuitively recognize this connection as evidenced by the vicarious suggestions they provided. Through vicarious suggestions the cooperating teacher placed themselves in the shoes of the pre-service teacher as they reflected on the lesson. The cooperating teacher also attended to salient outcomes of the lesson and used their noticing as evidence of the teaching elements that worked or did not work with their students. Being provided with the opportunity to observe these outcomes from an observer perspective rather than a teacher perspective provided teachers with access to information not accessible to them while teaching.

Finally, teacher noticing was shown to have influence in the teachers' personal domain. The data from this study provided evidence of teachers drawing connections between their noticing and their own practice. These connections demonstrate the various ways in which teacher noticing influenced teachers' thinking about their classrooms their students, and their own teaching practice.

The notion of professional experimentation finds its roots in the work of Kolb (1984) and others who suggest that learning involves a transaction between the learner and the environment. In this view, the learning experience in this case is defined both in terms of the objective elements of setting and event specifics, as well as the subjective elements of the prior knowledge and motivations of the learner. In terms of objective elements, data from this study show that teachers making connections to their own

practice was supported by the context-specific nature of the observation environment. While some teacher connections were general, many were based upon noticing specific students, content, and classroom resources available only in observations of their own classroom. Additionally, teacher noticing was influenced by the features of the lessons being taught as well as the tasks students were asked to participate in.

The data also suggests, that as learners, each of these cooperating teachers brought unique experiences and orientations with them. The descriptions that teachers gave of themselves as science teachers and cooperating teachers were presented in the case studies. These descriptions illustrate the subjective orientations each teacher brought to their experience. While this study does not attempt to address the ways in which these subjective elements influence teacher noticing, a deeper analysis of both the content and structure of individual teacher noticing may provide some insight into this interaction.

Russ and Luna (2013) describe a methodology for using teachers' descriptions about their noticing to understand the ways that science teachers frame various aspects of their noticing. In their work, the authors suggest that teachers frame their noticing in multiple ways within the course of a single lesson. The data on cooperating science teacher noticing also seems well suited to this type of analysis. Careful attention to the cooperating teachers' evaluative, interpretive, and transformative comments presented in this study may provide a window into the frames of reference the participants used to make sense of their noticing.

Predictions from the interconnected model of professional growth and findings from this study suggest that observations of pre-service teachers be considered a form of

professional development. Models are useful as predictive instruments and alignment of cooperating teacher noticing with the interconnected model of professional growth would predict that the act of noticing influences a teacher's knowledge, beliefs, and attitudes. The fact that teachers were seen to draw connections to their own teaching practice during the work of observation, reflection, and discussion lends support to this prediction. In this way, findings of this study assert that teachers use noticing as reflective practice. It also suggests that the act of noticing supports the development of knowledge in practice or craft knowledge, which is learned through "deliberation, consideration, and reconsideration of the flow of classroom action" (Cochran-Smith and Lytle, 1999, p. 268). The question of how this craft knowledge will manifest itself in the domain of practice remains to be answered.

IMPLICATIONS AND FUTURE RESEARCH

This study has made the case that cooperating teachers are uniquely positioned to learn from observations of pre-service teachers in their classrooms. These teachers observe in their own classroom context, watch their own students, and observe lessons directly applicable to their current topic of instruction. The insights they gain may be of immediate use in class periods later that day or on the following day. Findings show that teacher noticing stimulates pedagogical reasoning and promotes teachers in making connections to their own practice. Findings have also suggested that the things that teachers pay attention to have a role in directing the reflective process and influencing the knowledge in practice they craft during the experience.

Reconceptualizing the role of the cooperating teacher.

The findings described in this study suggest that thoughtful consideration of the factors that influence cooperating teacher attention during the observation process is warranted and a reconceptualization of their roles may be appropriate.

Directing teacher noticing.

One goal of studying teacher noticing is to understand teacher attention and consider ways to shift this attention to classroom elements necessary for reformed-based teaching. During a typical observation cooperating teachers are asked to focus on the pre-service teacher and give them pedagogical advice. These tasks likely direct their attention. Previous work in the area of teacher noticing in other contexts has demonstrated that teacher noticing can be refined and directed (van Es, 2011). If this is the case then it provides the science education community with some rich opportunities.

One implication from this study is that teacher preparation programs should give careful consideration to the design of the observation tools they provide for cooperating teachers to use. How well do these tools align with directing attention to the best practices in science education? How intentional are they in directing attention to learning as well as teaching? This study demonstrates that overall, teacher noticing was focused more on elements of the lesson than on student activity. This is not surprising given that the role of cooperating teachers is often conceptualized with a focus on teaching rather than learning. The Framework for K-12 Science Education suggests that teacher's need

skills in soliciting, acknowledging, investigating, and assessing student ideas (2012, p 265). With an increased focus on attention to student ideas, one might ask how we can support cooperating teachers in maximizing this observation opportunity as an occasion to attend more closely to characteristics and understanding of their students.

Using the K-12 Science Education Framework as a foundation for designing observation tools would be a place to start. If teacher attention is directed toward elements of student understanding, rather than on elements of the lesson, then perhaps conversations between pre-service teachers and their mentors will also focus on these essential features. Attention to these features may help both pre-service and inservice teachers in engaging in professional experimentation around developing a repertoire of strategies for teaching science in ways that support the expression of student ideas.

Supporting metacognition.

Directed noticing may also help the cooperating science teachers gain insight into their own classroom teaching. To foster this side of the work, teacher preparation programs should consider framing the observation task from the perspective of the cooperating teacher as a learner. Setting up learning as an expected outcome of their observations may position science teachers to pay closer attention to their own insights. In addition, preparation programs might ask their cooperating teachers to engage in reflective activities that would draw their attention to the implications of their own noticing. Interviews, like the ones presented in this paper, might be conducted with cooperating teachers at the end of each semester; perhaps the pre-service teachers could

be the interviewers. Another possibility stemming from this work would be asking the cooperating teacher to engage in reflective journaling. In this way cooperating science teachers are approached as life long learners and their work serves to model reflective practices for pre-service teachers.

Fostering classroom inquiry.

Perhaps by changing the orientation of the tasks set before cooperating teachers we can encourage them to notice more in the area of learning as well as foster their own metacognition. Some may argue that directing their noticing in this way would take a way from the primary role of attending to and guiding the pre-service teacher. It could also be argued that this reorientation would strengthen this role. Directing noticing to student outcomes would provide cooperating teachers with evidence-based noticing instances to use as a jumping off point to discuss the lessons with their pre-service teachers.

Cooperating teacher comments focused on evidence of learning rather than on teaching strategies may change the nature of the lesson debriefs they have with pre-service teachers. It may reorient the conversation away from advice giving toward a more collaborative inquiry into instructional practice based on student outcomes. Conversations of this type level the playing field by treating all participants in the conversation as investigators and learners. In addition, these conversations would model analytic and reflective practice for the newest members of our profession. Discussions of this kind may help both pre-service and cooperating teachers to develop the investigative

skills needed to be responsive to the needs of the diverse 21st century science classroom.

Nurturing school/university partnerships.

Another implication of this study is that teacher preparation programs judge teachers not only on their current practice but, as importantly, on their willingness to engage in thoughtful reflection and learn from inquiry into their classroom. Teacher preparation programs are often challenged to find "good" cooperating teachers. These are traditionally defined as teachers enacting best practices as determined by the preparation program. If teacher preparation programs are at the leading edge of best practices in the field then it is not surprising that it is hard to find teachers enacting these skills well. Finding from this study suggest hope for this situation.

This study argues for careful design of observation tools, metacognitive tasks, and collaborative lesson debriefs as a way to develop strong cooperating science teachers. By redesigning the nature of these tasks it may be possible for cooperating science teachers, pre-service teachers, and science teacher educators to move forward as a community by engaging in classroom inquiry. Work of this kind also supports partnering schools by supporting the professional development of their cooperating teachers. The knowledge of these cooperating science teachers can be a valuable resource for the other teachers, school administrators, and district personnel that they connect with.

Pivotal moments.

Schoenfeld (2011) makes the statement that teacher noticing can lead to change in teacher practice. While this study does not document change in the domain of practice due to the act of noticing, it does document the emergence of "pivotal moments". It can be argued that in the same way that students present teachers with "teachable moments" to be captured, that cooperating teachers display "pivotal moments" during the noticing process. These are moments during their complex work when the cooperating teacher has the chance to sit back and observe their classroom, notice specific elements, engage in professional experimentation, reflect, and recognize the need to develop specific areas of their practice.

Noticing data from this study uncovered pivotal moments for each teacher at several points within each lesson event. During these times, the cooperating science teachers made a connection to their current practice, found a point of dissatisfaction, and identified an area in which they felt the need to change. Unfortunately, opportunities of this kind are often left to wither on the vine. The question for the science education community, school administrators, and science departments is how to leverage these "pivotal moments" and use them to improve instructional practices, and how to link teacher insights to the larger issues of school, state, and nationwide reform efforts.

One possible answer is by moving from an individual notion of teacher knowledge to a collaborative one. Central to the concept of knowledge of practice is the vision of teachers engaging in investigations of classroom practice in a collaborative

environment. In this view, "teaching begins necessarily with identifying and critiquing one's own experiences, assumptions, and beliefs" (Cochran-Smith & Lytle, 1999 p. 279). As currently enacted, the act of teacher noticing as described in this study is a personal experience for teachers. Pivotal moments occur as teachers observe their own students, their own classroom, and evaluate their current practices, but these insights are rarely captured.

There is, however, potential for exploring these pivotal moments and developing knowledge through a more collaborative model. In this study, there were several anecdotal accounts of teachers sharing their insights at department meetings or with colleagues and they all reported finding it to be very rewarding. Perhaps teacher noticing could be used as the basis of collaborative inquiry in much the same way as video clubs. These inquiry groups could include various members of the educational community spanning years of experience. Groups could be formed to include any variety of stakeholders from pre-service teachers, to inservice teachers, administrators, and teacher educators. These participants could come together to discuss teacher noticing as well as the questions teachers generate about their practice during the process.

Having a variety of stakeholders would allow for the emergence of varied perspectives on the issues being raised. Though this work would require support from both universities and school campuses and a more complex vision of the roles of cooperating teachers, this model has the potential to leverage the pivotal moment and turn it into realized change.

Implications from this dissertation suggest that additional investigation into the factors that influence cooperating teacher noticing during the observation process is needed. Implications also suggest reconceptualizing the role of the cooperating teacher by redesigning observation tools, including metacognitive activities in the work of cooperating teachers, and reorienting lesson debriefs toward a notion of classroom inquiry. Further research in any of these areas would contribute useful information to the understanding of cooperating teacher learning and provide insight into ways to foster stronger school/university partnerships.

CONCLUSION

This study contributes to the current literature base on inservice teacher learning. It stands apart in that the study focuses on the secondary science cooperating teacher, an underexplored group. This study also applies the noticing framework, from mathematics education, to the secondary science context. The findings support other studies in the literature that show that teachers notice a variety of factors during observations of classroom practice. It also supports previous findings that suggest that teacher noticing is variable between teachers. It adds to the literature by identifying broad noticing patterns for the cooperating science teachers in this study. These teachers primarily attended to general pedagogy and representations of science content during their observations. In addition, the study showed that on a general level, cooperating science teachers paid more attention to the lesson being enacted than to their students.

This study found that cooperating science teachers regularly engage in reflection and pedagogical reasoning through the act of noticing. Teachers were shown to make regular connections to their own practice. These connections took the form of vicarious suggestions, reflective questions, comparisons of practice, and perspective shifts. It has been argued that these connections also fostered the emergence of "pivotal moments" or times when the cooperating science teacher self identified a need to make changes to their current practice. Findings from this study suggest that cooperating teachers use observations of pre-service teachers in their classrooms as a form of professional experimentation and that they build knowledge in practice through the experience. The findings suggest that observations of pre-service teachers be added to the list of professional development activities, like video analysis and lesson study, that have been shown to engage teachers in reflecting on their own practice.

For science teacher educators, this study demonstrates the importance of attending to field experiences as a learning opportunity for the science cooperating teacher. It provides a new way of looking at classroom observations as professional development opportunities and suggests that teacher preparation programs reconceptualize the tasks they ask cooperating teacher to engage in. Recommendations include designing observation tools that direct teacher noticing to student learning in science, viewing cooperating teachers as learners, including metacognitive activities for cooperating teachers, and reorienting lesson debriefs toward a notion of classroom inquiry.

Purposeful attention and cultivation of the development of cooperating science teachers has far reaching potential. First, each of these cooperating teachers is part of a

larger educational network. They teach science to high school students, train pre-service science teachers, and often work as part of campus and district science teams. Their improved teaching practices touch each of these communities. Second, this work may help define new ways for school administrators and districts to ensure in-house professional development for their cooperating teachers. Third, this research has the potential to redefine school/university partnerships into robust and cooperative teams. Finally and perhaps most importantly, this work has the potential to directly impact future STEM workforce efforts by helping all science pupils learn through improved science instruction. In these ways, the development of cooperating science teachers provides a potentially powerful mechanism for change in science education.

Appendix

INSTRUMENTS

Sample noticing instrument (Page 1 of 4).

[redacted]

11/14/2011

7th period [redacted] AP Bio

What Do I Notice?

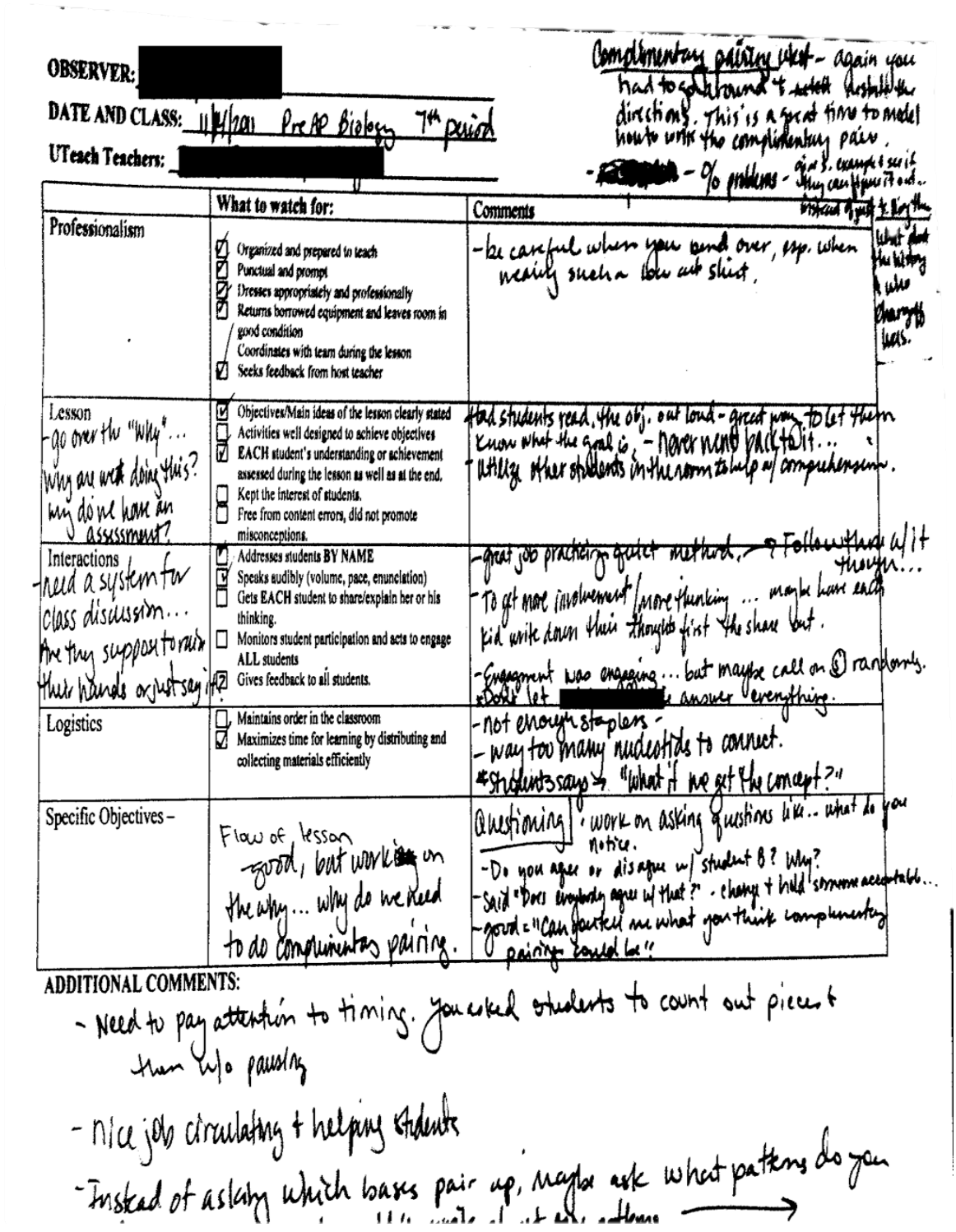
The act of noticing is describing what stands out to you as you watch the science lesson in your classroom today. In the space below, please note the time (if you can) and write down moments that stand out to you and get you thinking about your own practice in some way. This document is a way to record your thinking in real time.

Class starts @ 2:46

Time	What I Noticed?
2:48	2 minutes after bell - teachers not starting - didn't look prepared... Engagement - - Missing person answers - good questions, but not all leads thinking. - Reflect → How can you ↑ students thinking about the ?s? - ~~Caleb was~~ For part of the discussion, it seemed like Caleb was the only one Jonathan was talking to. - you asked them to count out their pieces & then w/o any time - ask someone to tell you what goes into a nucleotide.

(1)

Completed observation form (front).



OBSERVER: [redacted]

DATE AND CLASS: 11/4/201 PreAP Biology 7th period

UTeach Teachers: [redacted]

Complementary pairing intro - again you had to go around & model the directions. This is a great time to model how to write the complimentary pairs.

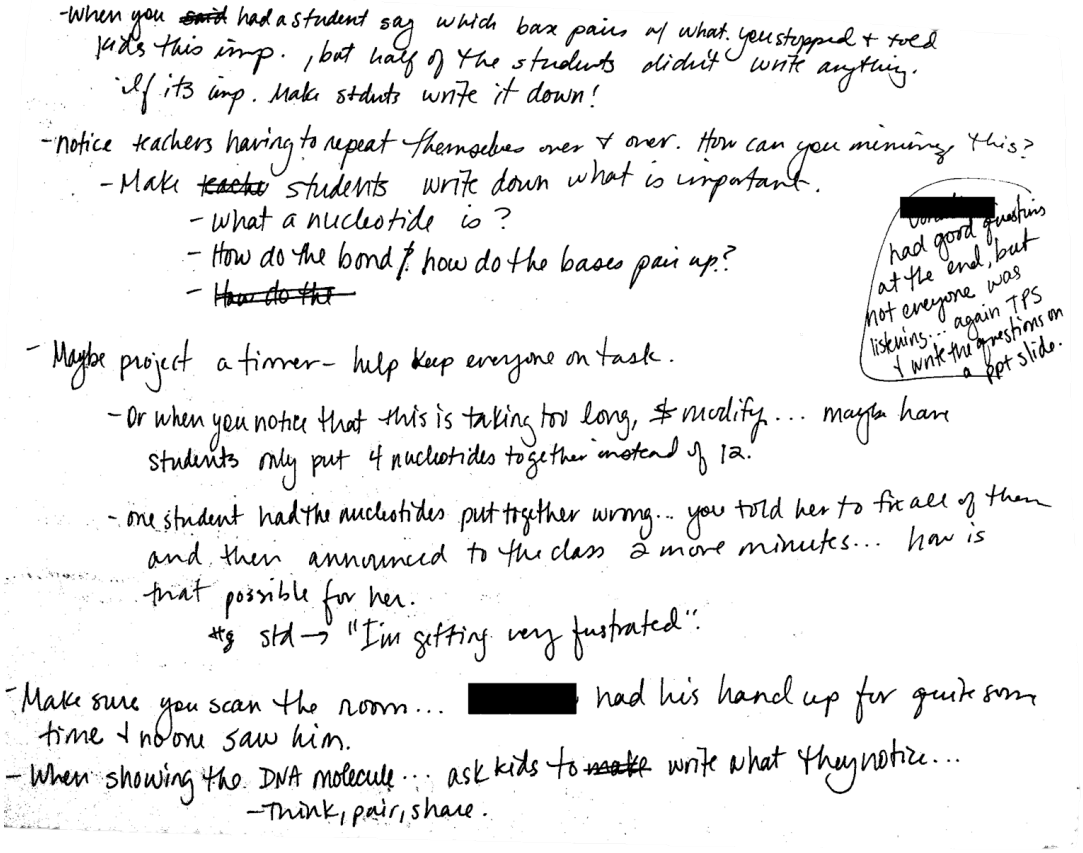
- [redacted] - 0/0 problems - give ex. example & see if they can figure it out... instead of just telling them what about the history & who changed the tests.

	What to watch for:	Comments
Professionalism	☑ Organized and prepared to teach ☐ Punctual and prompt ☑ Dresses appropriately and professionally ☑ Returns borrowed equipment and leaves room in good condition ☐ Coordinates with team during the lesson ☑ Seeks feedback from host teacher	- be careful when you bend over, esp. when wearing such a low cut shirt.
Lesson - go over the "Why"... why are we doing this? why do we have an assessment?	☑ Objectives/Main ideas of the lesson clearly stated ☐ Activities well designed to achieve objectives ☑ EACH student's understanding or achievement assessed during the lesson as well as at the end. ☐ Kept the interest of students. ☐ Free from content errors, did not promote misconceptions.	had students read the obj. out loud - great way to let them know what the goal is. - Never went back to it... utilize other students in the room to help w/ comprehension.
Interactions - need a system for class discussion... are they supposed to raise their hands or just say it?	☑ Addresses students BY NAME ☑ Speaks audibly (volume, pace, enunciation) ☐ Gets EACH student to share/explain her or his thinking. ☐ Monitors student participation and acts to engage ALL students ☑ Gives feedback to all students.	- great job practicing guided method, & following through w/ it the whole... - To get more involvement/more thinking ... maybe have each kid write down their thoughts first then share out. - Engagement was engaging... but maybe call on (5) randomly. *Don't let [redacted] answer everything.
Logistics	☐ Maintains order in the classroom ☑ Maximizes time for learning by distributing and collecting materials efficiently	- not enough staplers - - way too many nucleotides to connect. *Students says → "What if we get the concept?"
Specific Objectives -	Flow of lesson - good, but working on the why... why do we need to do Complimentary pairing.	Questioning - work on asking questions like.. what do you notice. - Do you agree or disagree w/ student B? Why? - Said "Does everybody agree w/ that?" - change + build someone accountable... - good = "Can you tell me what you think complementary pairing should be."

ADDITIONAL COMMENTS:

- Need to pay attention to timing. You asked students to count out pieces & then told to pause.
- nice job circulating & helping students
- Instead of asking which bases pair up, maybe ask what patterns do you →

Completed observation form (back).



Sample field observation.

Field Observation

Teacher Name: (REDACTED)	Date and Period: 4/2/12
Observer Name: Rodriguez	Time: 9:00-10:33

General Description of the lesson observed:
Plant structure and function
9:02 PST pulls up a power point on vascular and non-vascular plants (warm up)
9:16 PST ends warm up and tells students about the research project they will be doing on plant structures
9:20 Students move into groups and start working on research project
9:58 PST stops research and tells students they will now present
10:00 Student presentations begin
10:18 PST uses doc cam to summarize information from presentations

Room Description:
See photos – students sit at tables of two facing the front

Codes:
CT= cooperating teacher PST = pre-service teacher IT = inclusion teacher
W(O) = CT is writing on the observation (feedback) form
W(N) = CT is writing on the noticing instrument
st = student highlight = ask for clarification in post interview
Scan = scanning the room

Observation Notes:

9:02 writing name and other information on O
9:03 watches front
9:04 watches front
9:05 watches front as students try to guess between two pictures of plants on ppt – which is vascular/ non
9:06 watches front – write O (box 1 and 2)
9:07 talks to me trying to interpret the plant pictures "I don't know I couldn't tell what was on the first set – I can see on this one"
9:08 watches front – write O – box 4
9:09 "closer to the ground" restates one of the ideas she hears from her students as they discuss how they are choosing which plants are vascular – listening – watching students
9:10 giggles at st response – watches student – write N
9:11 talks to IT as IT points to the PPT and makes a comment – write N

9:12 watches front
9:13 write O – watches front
9:14 watches front – looks at watch
9:15 prepares to write N – makes comment to IT – write N
9:16 write N
9:17 watches front
9:18 watches front – talks to IT
9:19 writes O (top box)
9:20 writes O – watches front
9:21 staring at floor – yawn – watching PST distribute paper
9:22 plugs in her laptop and places it in front of her – on laptop
9:23 on laptop – watching front
9:24 talking to IT – watching front
9:25 write N – giggling with IT – write O (bottom of sheet) – talk with IT
9:26 talking with IT – looking over N- watching group close to her as PST gives out supplies – talking to IT- yawn- looking over N
9:27 write N- talking to IT – write N
9:28 scan, watching PST move around the room – looks at O form- yawn
9:29 looks at LP
9:30 watching group at back – gaze moves between back groups – "(student name redacted), as usual – like you said" to IT (from students telling out)
9:31 puts on sweater – talks to IT – scan
9:32 write O (bottom) – scan
9:33 talk to IT – write N – PST comes back to ask about a student that went to the bathroom and has not returned
9:34 CT talks with the PST about this student – after PST goes back to front – to IT "yeah, we should not let her go anymore"
9:35 reading over N (unfinished comment) – write N
9:36 scan, talk to IT, looks at watch – talks to IT
9:37 talks to IT – listens as IT as she talks to student (S2) who was gone at RR and just returned late
9:38 giggles as she listens to a students talking to PST – comments to IT (about student?)
9:39 scan – talks to student (S3) that comes back to ask for a drink of water. St 'is this for a grade?" CT nods "oh then I am going to fail"
9:40 talks to IT about this students as she leaves to get water
9:41 scan – giggles at S1 again – scan
9:42 scan – write N – comments to IT- write N
9:43 write N – scan
9:44 scan – looks at O – write O (box 3)
9:45 scan – giggles with IT as S1 says the poster needs to be "grammatically accurate" - Scan
9:46 scan – looks at O – scan

9:47 PST comes back to ask if she should give the groups extra time to work on their poster. CT says yes and looks over LP to talk with the PST and give suggestions about what she might cut back
9:48 comments to IT about how she decided what cuts to recommend "I know it is important but …"
9:49 scan - watches an off task group at the back of the class
9:50 write O (bottom) – scan
9:51 write O (bottom)
9:52 write N
9:53 scan – write N- looks over O – comments to IT that has just come back to her seat from redirecting a group
9:54 looking at O – scan
9:55 write O (box 4) – looks out window – scan
9:56 scan – looks at phone- giggles at "transpiration/ transportation" (student comment) and repeats what student said – scan
9:57 – scan – watches group closest to her – scan –watches back group on other side of the room
9:58 "do they have a sheet to write down?" to IT – watches front
9:59 talks with IT trying to make sense of what it going on
10:00 watches student presentations
10:01 listens to students as they ask questions of the presenters
10:02 looking at O – write O (box 4)
10:03 watching front as presenting groups transition - shows IT something on the LP and comments on it
10:04 talking to IT – watches front
10:05 watches front
10:06 watches front
10:07 watches front
10:08 watches front
10:09 watches front – redirects loud student at the front
10:10 calls PST over and gives her some pointers?? While next group goes up to present – points to LP as she talks to PST
10:11 watches front
10:12 watches front
10:13 watches front – write N
10:14 write N – watches front
10:15 write O back
10:16 gets up to set up doc cam from PST
10:17 return to seat – watches front – write N
10:18 write N- listens as students answer questions from PST
10:19 comments to IT – watches front
10:20 watches front – sighs – write N
10:21 write N – watches front – looking over N – nods as IT comments to her – write

N
10:22 write N
10:23 watches front
10:24 checks phone – texting – watches front
10:25 watches front
10:26 watches front – shifts in chair
10:27 watches front
10:28 watches front – write O (back)
10:29 write O
10:30 watches front – talks to me about LP "I thought she had stations for day 2"
10:31 write on LP – lesson end

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Vita

Shelly R. Rodriguez currently works as a clinical assistant professor for the UTeach program at the University of Texas in Austin. Her previous experience included a role as science department chair at a local high school. Ms. Rodriguez is a National Board Certified science teacher with 12 years of secondary science teaching experience. She earned an M.A. in science education in 2003. Her interests in science include evolution, genetics, and animal behavior. She has an array of experience in field-based scientific inquiry, ranging from studying mating preference of tropical frogs in at the Smithsonian Institute in Panama to working with scientists at the University of California-Davis on undergraduate research projects for minority students. Ms. Rodriguez has also worked extensively with beginning and pre-service teachers and provides an authentic and committed voice, which advocates for community and district partnerships on both the University and school level.

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This dissertation was typed by Shelly R Rodriguez.